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The WELDING Journal

The Journal of the American Welding Society

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MAY 1943

VOLUME 22 NUMBER 5

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Completing Test Run on M-4 Tank.
Courtesy Pullman-Standard Car Manufacturing Co.

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Design and Construction of Underframes for All-Welded Railroad Passenger Cars*

By J. E. Candlin, Jr., and A. M. Unger†

THE American Railroads have been very successful in the handling of passengers with comfort and speed for they have always emphasized passenger safety. The careful design of railway passenger cars is the most important reason for the remarkable safety record that has been established. Before the era of lightweight cars, safety was accomplished by the use of excess metal in the construction, but with the introduction of modern streamlined trains during the last decade, the premium placed on lightweight construction would not permit an inefficient design to be used.

Reduced weight is now very important in the industry, since the railroads have been forced, by competition, to operate at the greatest possible efficiency, and the use of lightweight equipment allows longer trains and higher scheduled speeds. During this last 10-yr. period, many new materials have been made available for car construction and new methods of fabrication and assembly have been developed. The designer must choose the right materials for construction, use the proper amount of material to withstand the forces encountered and assemble the material by the most efficient method.

Given the proper material, it is not enough to use the correct amount without providing sufficient connection between the various parts. Welding is the most important gift given the railway car designer for his use in producing a lightweight steel car. In using this tool he can keep the cost of construction as low as possible by eliminating the use of expensive dies and machinery. The maintenance costs also are kept low due to the omission of lap joints which invite corrosion. He can design a structure that is welded into a unit instead of one which is a collection of parts. He can build a structure which has the exact properties he desires in-

* First Prize Award paper in Class C Railroads Division of the 1940–42 Industrial Progress Award Program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. The award papers showed a possible saving of $1,825,000,000, including 7,000,000 tons of steel and 153,000,000 man-hours of labor available by application of arc welding.

† Assistant Engineer of Passenger Cars and Assistant to Superintendent, respectively, Pullman-Standard Car Mfg. Co., Chicago, Ill.

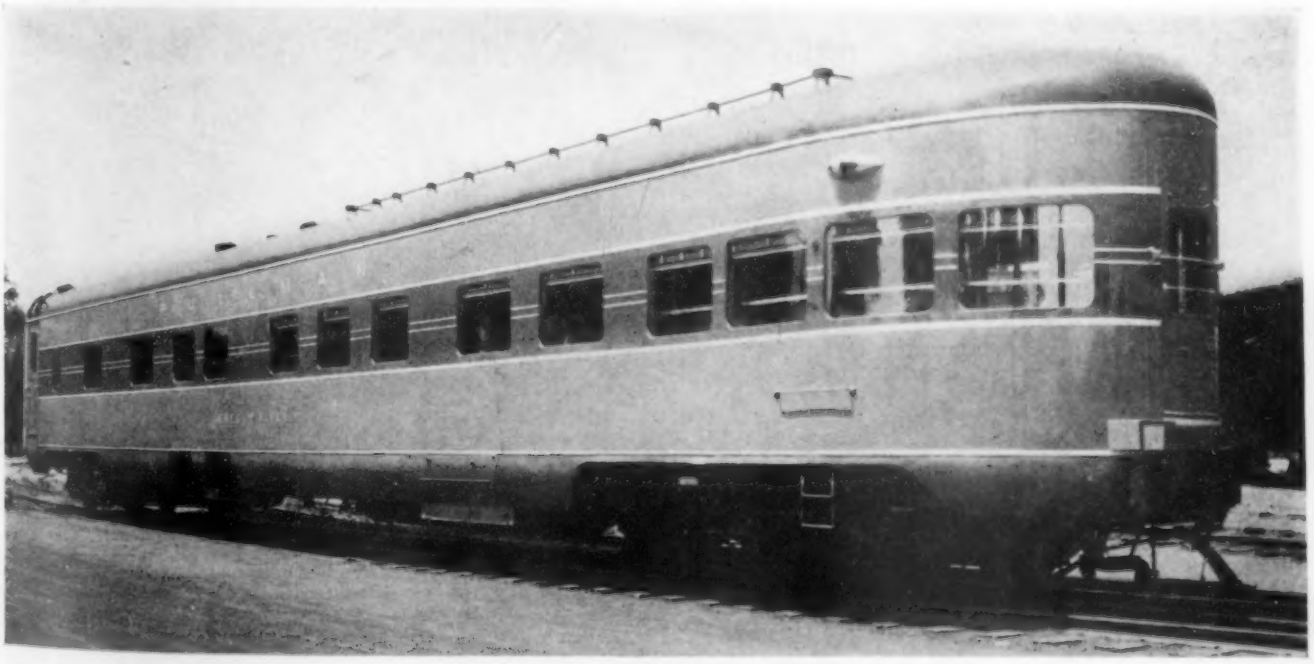


Fig. 1—The Modern All-Welded Steel Passenger Car

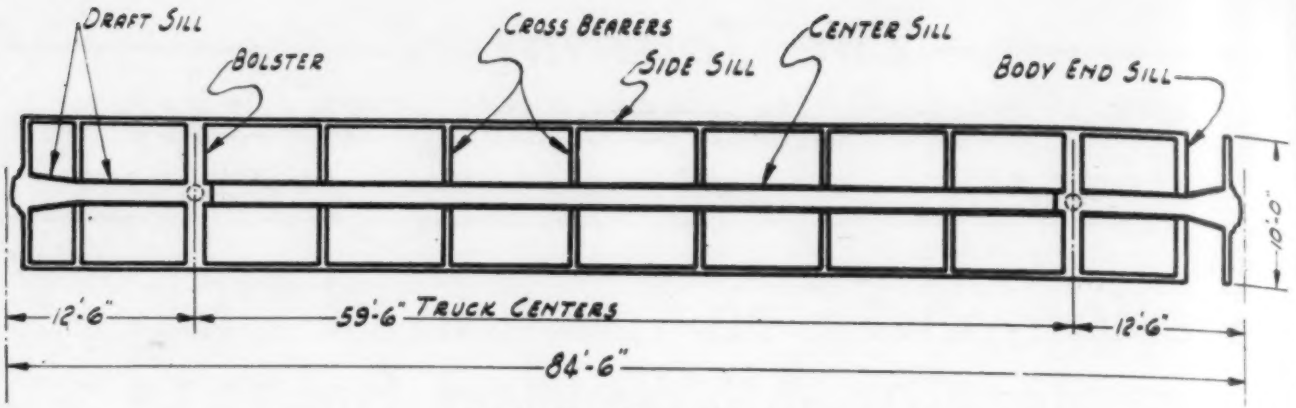


Fig. 2—Plan View of Underframe

stead of using a rolled or pressed section which is available. As a result, the strength of the finished car can be increased when less material is used.

For many years, all structural parts of a railway passenger car, whether of rolled or cast steel, were riveted together. When welding was first introduced, it was used only on minor parts that carried no important loads. As welding was developed, it soon proved economical in other parts of the car, and today very few non-welded parts are used. Even these are being replaced one by one with welded assemblies. Since 1936, the standard construction for steel passenger cars has been the all-welded car (see Fig. 1).

Specifications and Design

A railway car structure may be divided into two principal parts: the superstructure, that portion of the car which is above the floor line; and the underframe, that portion below the floor. The sides, roof and ends which compose the superstructure of the car were previously of riveted construction but are now all welded. For each side or end, the framing is all assembled by arc welding the rolled and pressed members together into a framework. All the sheets are arc welded together to form a covering for the framework. This large covering sheet is then spot welded to the framework to form a finished side or end.

Welding has also replaced riveting in the underframe. The underframe is made up of many parts as shown in Fig. 2; the principal member is the "backbone" comprising the "center sill" and the extending portion of it which is called the "draft sill."

The latest item on the car to be changed to an arc-welded design was the draft sill structure. The coupler is attached to the draft sill as shown in Fig. 3. The underframe must be designed to support the floor loads as well as the forces from adjacent cars which are continually pushing and pulling while the train is in operation. The buffing forces from the coupler are transmitted to the draft sill at point *A*. These forces are a result of the train starting and stopping and are also present while the train is in motion. The design of the draft sill is a very important problem because of the high stresses involved and because the draft sill is subject to high impact and fatigue (see also Fig. 4).

The need for a strong center sill construction always has been apparent and was recognized by the Government in 1912 when the post office department approved the first "General Specification for the Construction of Steel Railway Post Office Cars." This document was the first general specification for construction of steel railway passenger cars and has been revised five times in a period of 26 yrs. The last revision was made in 1938. Although no general specification such as this was adopted by the Association of American Railroads during this period, the Post Office Specification was followed by the leaders in the car-building industry for the construction of all cars whether they were to carry mail or not. It was assumed, of course, that the protection of passengers was as important as the protection of mail and mail clerks. Moreover, definite advantages could be claimed by making all cars in a train of equal strength.

With the above thoughts in mind, and in an effort to compel *all* railroads and car builders to build cars that would provide maximum safety, the Association of American Railroads adopted as recommended practice, in the latter part of 1939, "Specification for the Construction of New Passenger Equipment Cars." This specification was written to cover all cars operating in passenger trains, whether mail, express, baggage or for passengers only, and, because it was by far a more rigid specification than that of the Post Office Department, this new set of rules was destined to affect the entire building industry.

For many years, previous to the adoption by the

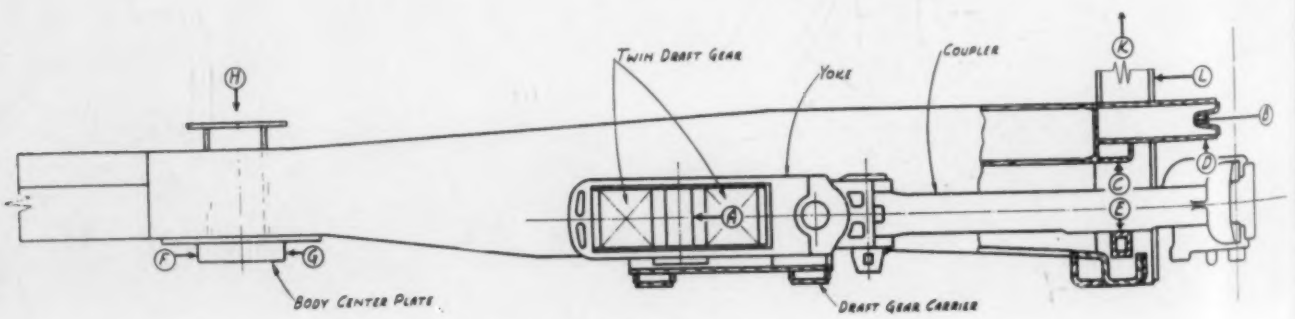


Fig. 3—Side View of Draft Sill

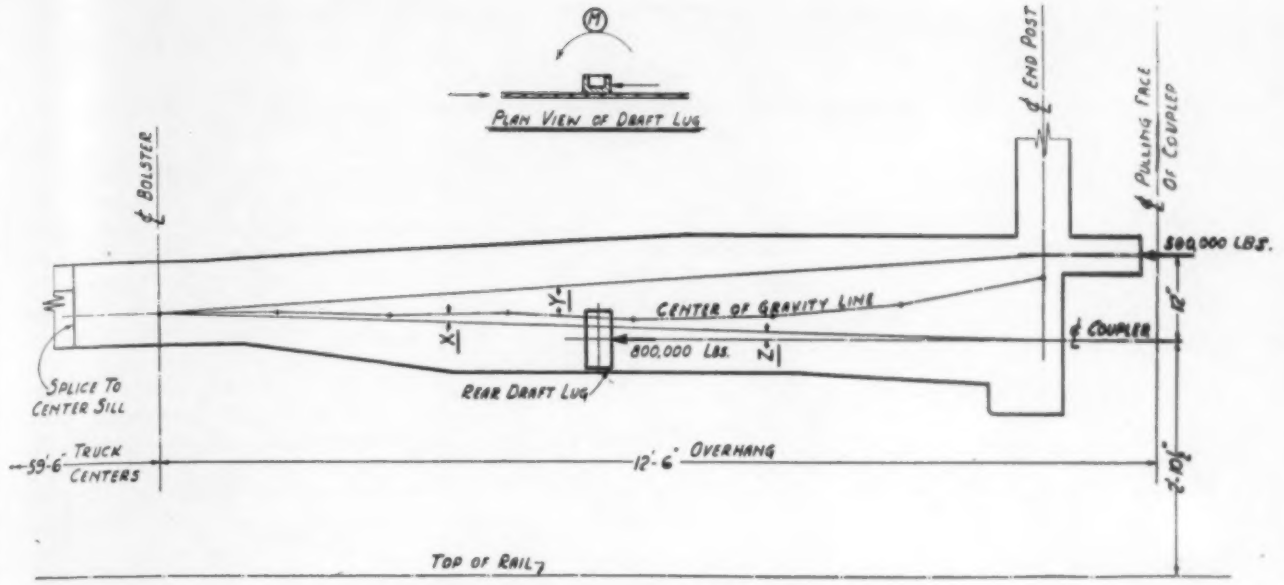


Fig. 4—Method of Calculating Strength of Draft Sill

A.A.R. of their first code covering construction of passenger cars, welding was not generally used in the industry and the railroads had a choice, for the important draft sill, of using a construction of rolled steel in riveted form or a huge steel casting. The riveted structure, while considerably lighter and less expensive than the casting, was of ample strength to meet the then existing rules for construction. Experience in operating cars over a long period has shown the riveted type of construction to be well engineered for passenger safety. The cast draft sill was, of necessity, penalized in weight and cost because it was impossible to make a casting with very thin walls. The additional metal used was also necessary because of the allowance that

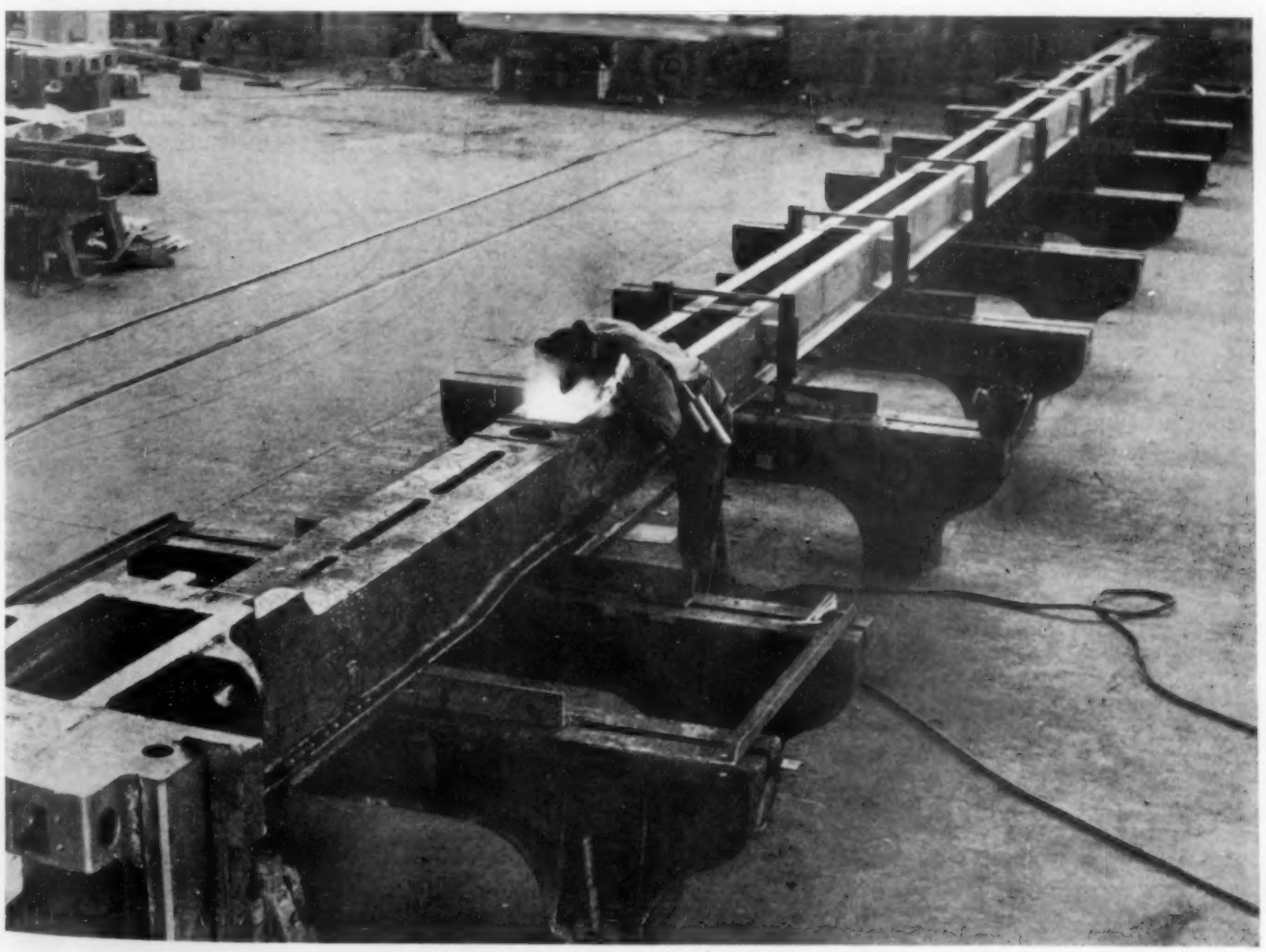


Fig. 5—Attaching Cast Draft Sill to Center Sill

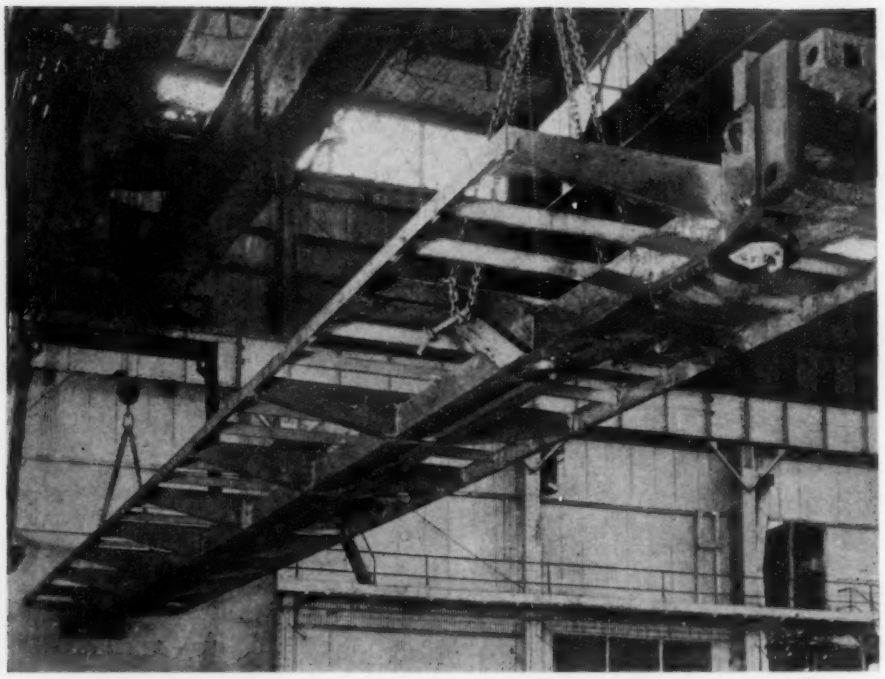


Fig. 6—Completed Underframe with Cast Draft Sill

must be made for porosity in a casting. (The A.A.R. specifications state that the allowable tensile stress of cast metal shall be limited to 80% of that allowed for rolled metals.)

Just before the new A.A.R. rules took effect, some welding was used in the draft sill but this was limited to attachment of castings to rolled sections and plates. The engineer designed the center sill to run all the way to the end of the car and supplemented it with a few steel castings. In this way the draft sill became an integral part of the center sill. This was possible because at that time a buffing device was used to relieve the coupler of a portion of the buffing load.

After the adoption of the A.A.R. specifications which provide for the use of tight-locking couplers without a buffing device, it was necessary to add great strength to the draft sill which addition would probably double the weight of this member. This large addition in weight allowed the casting construction to compete on an equal basis with the riveted construction; in fact, the engineer found it difficult to provide sufficient rivets to meet the required strength. The steel casting, although heavier, could easily be made to comply with the new requirements and was used on several of the succeeding designs (see Figs. 5 and 6).

After an analysis of various types of construction and materials, it became evident that welded assemblies would provide outstanding advantages and that an entirely arc-welded draft sill could be designed, which would be stronger, lighter and less expensive than either a riveted or cast sill. The introduction of the modern low-alloy, high-tensile steels made the *welded* draft sill a *much better* construction than a cast draft sill because of the additional saving that could be made due to the use of this steel. Figure 7 shows an all-welded alloy-steel draft sill.

A.A.R. Specifications

Since the A.A.R. specifications are new to many men in the business, the following will serve to explain briefly the main points to be considered. The strength requirements for the draft sill can be summarized as follows (see Fig. 3):

1. The draft sill should stand a horizontal load of 800,000 lb. applied at the rear stops (*A*) on line with the center of the coupler without permanent deformation. This force represents the maximum load on the coupler. (This load is actually applied in a "squeeze test" which is sponsored by the Association, this test to be made on all new designs.)

2. It should resist a horizontal load of 500,000 lb. applied on its extreme end (*B*) at a point 12 in. above the coupler line. This portion of the sill is called the "center end sill." This force represents the maximum load on a "buffing device" that is sometimes used at this location.

3. The center end sill should resist an upward thrust of 100,000 lb. (*C*) at any position the coupler may take. This force should be considered as being applied at *D* as well as at *C*, and it represents the maximum climbing force of the couplers. The center end sill is made to extend almost to the center line of pulling face of the coupler so that a conventional coupler on the adjoining car cannot slide vertically upward to disengage. This arrangement meets the anticlimbing requirements of the specification.

4. The coupler carrier (*E*) should stand a vertical downward load of 100,000 lb. applied at any coupler position. The carrier is actually spring suspended but the member just below it may be made to meet this rule.

5. The body center plate should be attached so as to resist a force of 250,000 lb. applied in any direction, as at *F* and *G*. This represents the force that should be set up by the truck in resisting telescoping of the cars.

6. Each main vertical end post (a portion of which is shown on the sketch) should be of sufficient shear area and should be attached to the end sill so as to resist a horizontal load of 300,000 lb. applied at *L* just above the end sill. These posts are anti-telescoping members and together they afford a resistance of 600,000 lb.

Referring to items 1, 2 and 6, above, it is evident that the draft sill must be designed to stand a load of approximately 800,000 lb. applied on its end in almost any position. This accounts for the serious addition in weight over the old designs where this force was applied at one point only.

7. All vertical reactions due to any of the above forces or moments may be resisted by the bolster at *H* and the framing at *K*.

Fig. 7—Welded Draft Sill

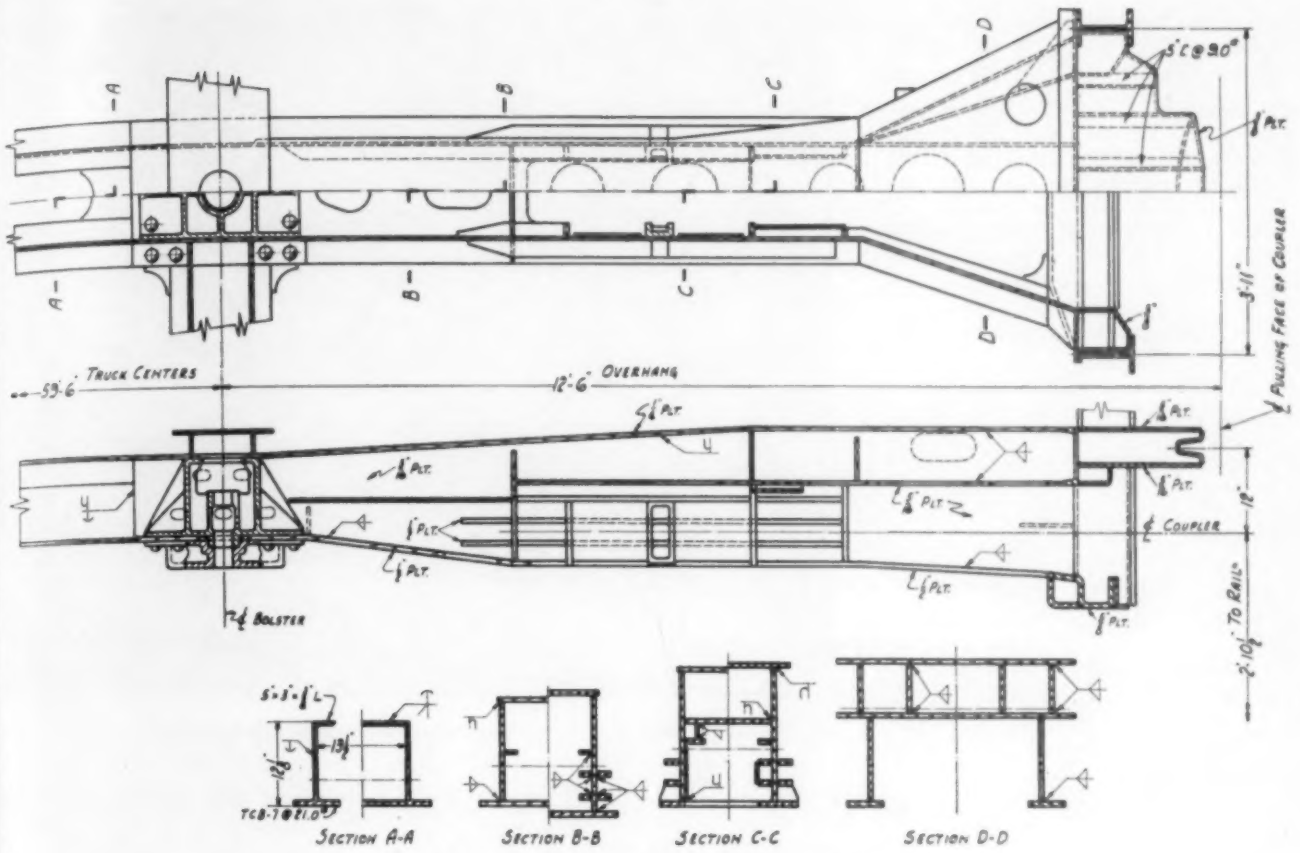
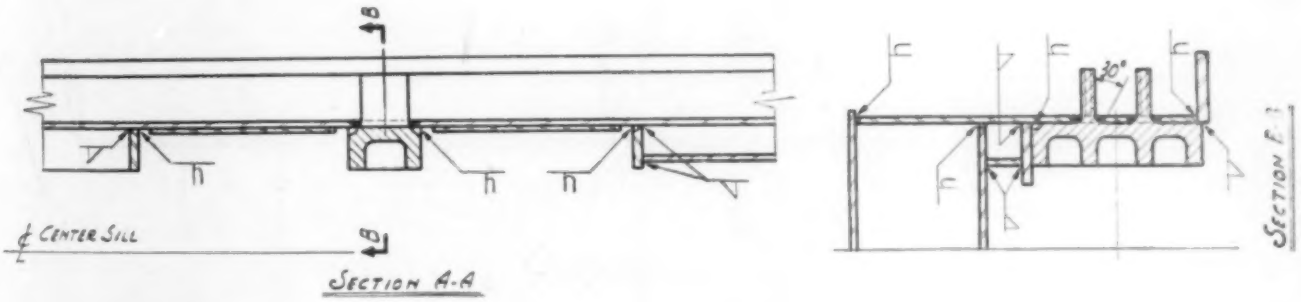
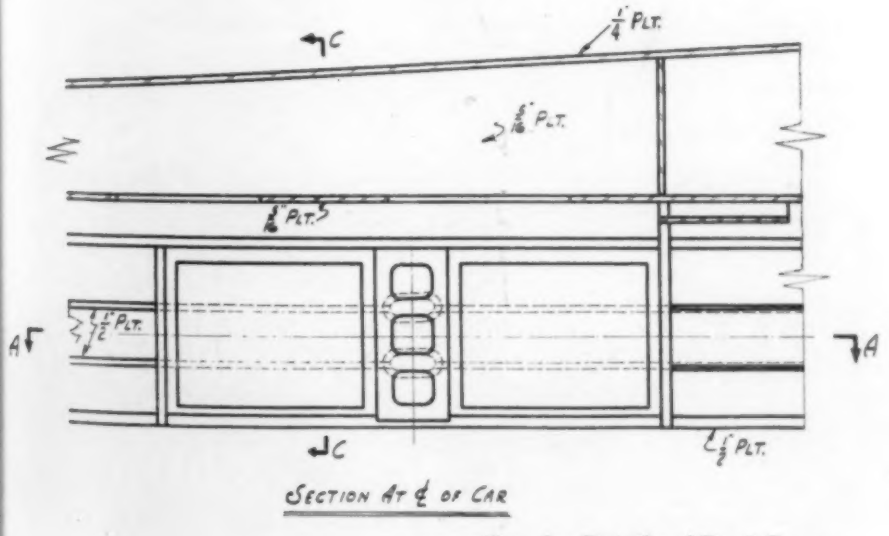


Fig. 8—Assembly of Welded Draft Sill





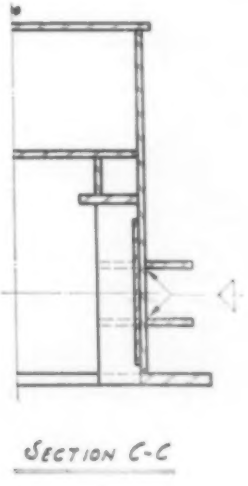


Fig. 9—Details of Draft Lugs

Method of Calculating

For the first two parts of the specification in 1 and 2, p. 312, it was found, on very careful analysis, that the following method of calculation would apply (see Fig. 4):

F = Fiberstress at extreme fiber of section.
S_t = Section modulus at top of section.
S_b = Section modulus at bottom of section.
S = Minimum section modulus.
A = Area of section.

The stress at any section due to the load of 500,000 lb. applied 12 in. above center line of coupler:

$$F = \frac{500{,}000}{A} + \frac{500{,}000\,Y}{S_t}$$

The stress at any section between the center line of bolster and rear draft lug due to the load of 800,000 lb. applied at the rear draft lug:

$$F = \frac{800{,}000}{A} + \frac{800{,}000X}{S_b}$$

The stress at any section between the rear draft lug and the center line of end post due to the 800,000 lb. load:

$$F = \frac{800{,}000Z}{S}$$

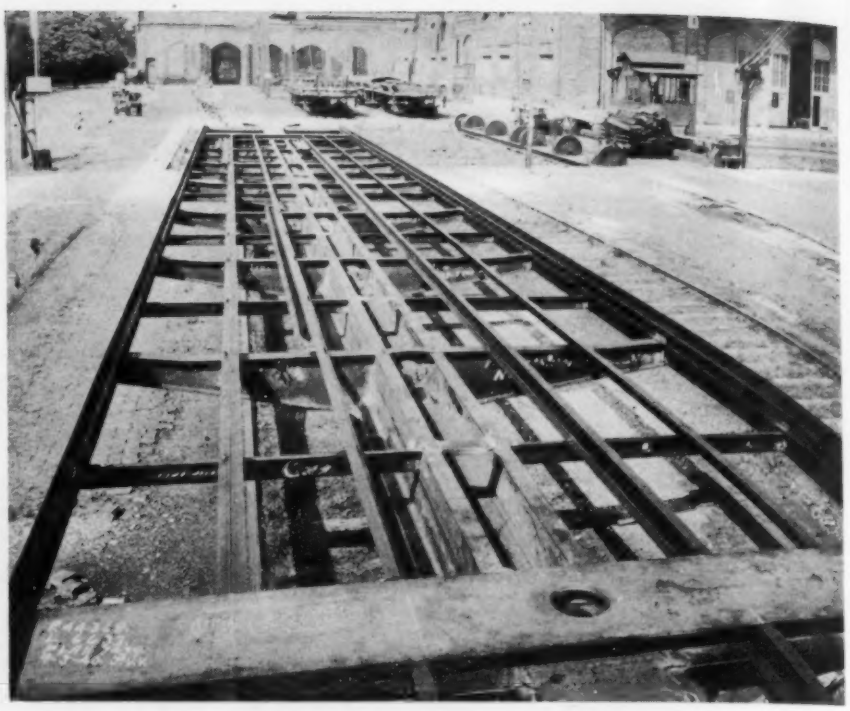


Fig. 10—Completed Underframe with Welded Draft Sill

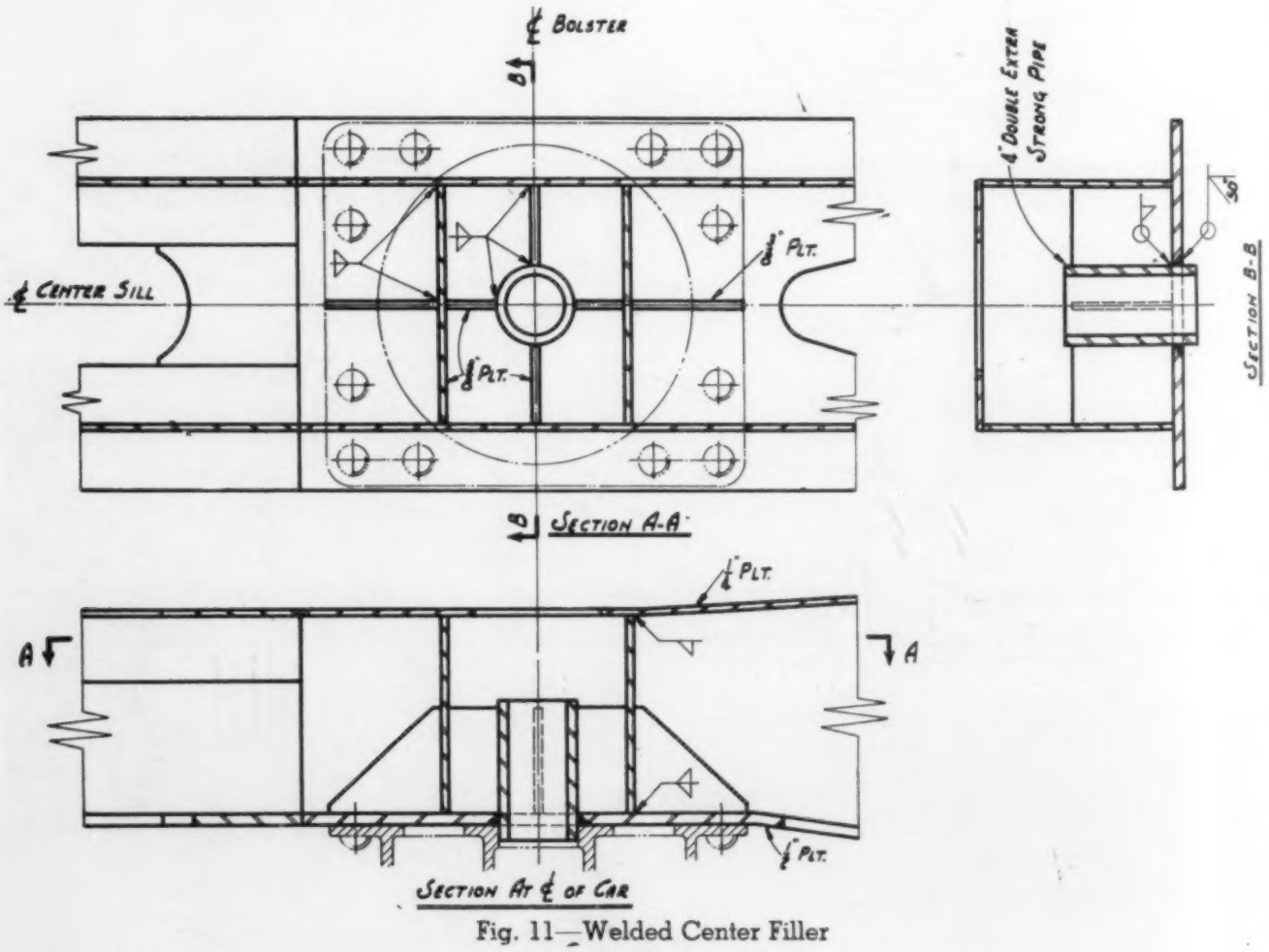


Fig. 11—Welded Center Filler

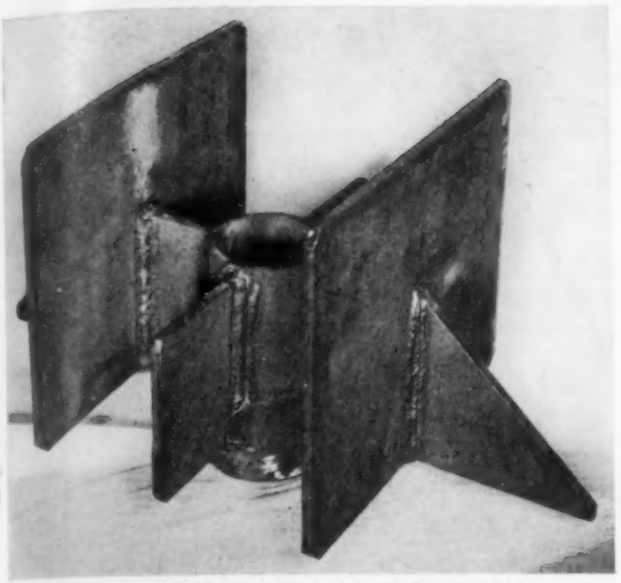


Fig. 12—Sub-Assembly of Welded Center Filler

The dimensions X, Y and Z are measured from the center of gravity to the straight lines drawn as shown in Fig. 4.

The above formulas, when used so as to give stresses below the yield point of the material by sufficient margin for safety in the so-called "squeeze test" referred to previously, will give the plate thickness necessary to form a satisfactory draft sill. Of course, detailed study must be made of the following points:

(*a*) The center of gravity of the centersill should lie in approximately the same horizontal plane as the center of gravity of the draft sill so that no moments will be set up at the splice between these two members. Where no eccentricity exists at the splice, the bending moment in the sill at the bolster is very low because of the great stiffness of the draft sill. This small moment can be ignored.

(*b*) The draft lugs should be checked carefully to make sure that they are backed up by sufficient ribbing so that no upsetting will occur in the ribs. This will prevent failure of the weld between the lug face and the draft sill web.

(*c*) Due to the fact that the load is applied on the draft lug face over an area whose center lies about 1 in. from the center of the web which must ultimately take this load, a horizontal rotating moment (M) will be present. This moment must be resisted in part by the top plate of the draft sill, partly by the bottom flange and horizontal ribbing on the web and partly by the draft gear carrier which is bolted to the bottom of the draft sill under the draft gear (see Figs. 3 and 4).

(*d*) It is important to investigate the "center end sill" to make sure that there is enough resistance at that point to develop 500,000 lb. and that the attachment of the buffer beam to the webs and top plate of the draft sill will transfer this force into the draft sill.

(*e*) The center end sill should be checked for strength to resist the force of 100,000 lb. upward at both points.

(*f*) The coupler carrier should be checked for a force of 100,000 lb. downward at any coupler position.

(*g*) The entire job should be calculated carefully to make sure that the small details are adequate and that the welds are properly specified.

Several "squeeze tests" have been made on welded cars having welded draft sills designed in this way. These tests were made at the Altoona shops of the Pennsylvania Railroad. During one of these tests, strain gages were applied to the various parts of the car, particularly the draft sill. It was found that the stresses in the draft sill followed very closely the calculated stresses and that *all* stresses were well below the yield strength of the material. Furthermore, at least 1000 draft sills that were calculated in this way have been constructed and not a single service failure has appeared. With one exception, all of the cars built since the design of this type of draft sill have used the welded type. It has been used on aluminum cars as well. This experience with welded draft sills proves beyond a doubt that, for equal weight, no other construction could be used to give greater safety or lower cost.

Details of Construction

The construction details and assembly of the all-welded draft sill are shown in Figs. 8 and 9. The member is principally of a box section comprising two vertical web members each $^5/_{16}$ in. thick, a top plate $^1/_4$ in. thick and a bottom plate $^1/_2$ in. thick. It is spliced to the center sill with a butt weld and reinforcing plates at top and bottom as shown just to the left of the bolster. The entire weight of the car body is carried to the truck at the center of the bolster where a "center filler" (shown as a casting) is used. The center sill is made by welding the toe of a rolled angle to the stem of a rolled tee to form a J-C section and it is supported on the load-carrying sides at approximately 8 ft. 6 in. centers by the "cross bearers" which are welded I-sections built up from plate to form a tapered beam. Figure 10 shows the complete welded underframe. The bolster is a double-webbed welded member which carries the entire body weight to the center filler. All cross members are welded to the side sill and center sill. The center filler, which previously has been a casting, was plug-welded to the webs of the center sill.

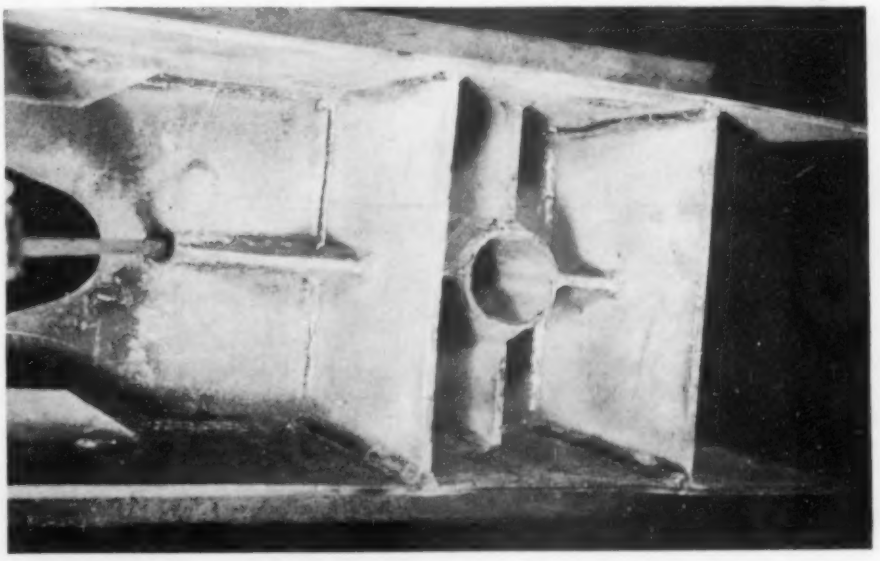


Fig. 13—Welded Center Filler Applied to Draft Sill

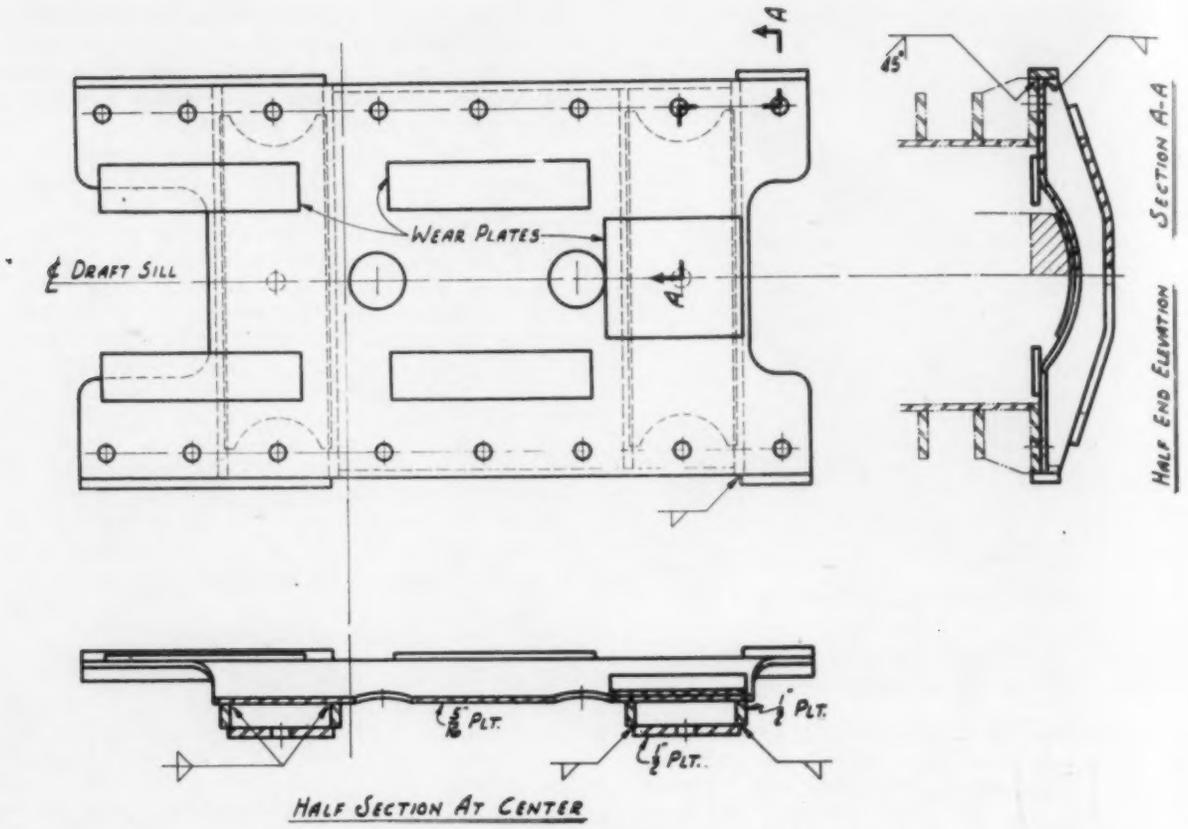


Fig. 14—Welded Draft Gear Carrier

A new welded center filler is shown in Figs. 11, 12 and 13. This has lately been applied to one new passenger car for trial and, after being proved successful, is to be incorporated in future cars as standard practice. The welded center filler saves a large percentage of weight since the cross ribs are welded directly to the center sill, eliminating the entire side webs of the cast type. The "center plate" (see Fig. 3) which is the swivel bearing to the truck is riveted in place because it must be removed when wear takes place. The center filler and center plate are interlocked as a safety measure in case the rivets are sheared by the force of 250,000 lb. referred to in item 5 under "A.A.R. Specifications."

The details of the draft lug attachment are shown in Fig. 9. The center lug which is a small steel casting must take most of the thrust from the coupler. It is cast with two legs which project through holes in the web of the sill to which they are welded. These legs are in turn welded to longitudinal ribbing which distribute the twisting moment described in item (*c*) under "Method of Calculating." Elimination of this casting and substitution with an arc-welded steel lug are being considered at the present time because of the uncertainty connected with the use of a casting.

Directly below the draft lugs, the draft gear carrier is bolted to the bottom of the draft sill (see Fig. 14). This piece serves to support the draft gear and coupler tail knuckle (which must be removed periodically) but at the same time the carrier ties the lower flanges of the sill together to resist spreading, closing or twisting, in case of a severe blow on the coupler.

Before the end of 1939, steel castings were *always* used for the center filler, draft lug housings and center end sills. The center end sill now used is entirely arc welded from plates and rolled channels. The vertical end posts are attached to the vertical portion of the end sill by welding through slots as well as by two fillet welds about 2 ft. in length. The end posts are a rolled CB section, but, because the web of this section does not have sufficient area to meet the rules, the web is burned out and a thicker one welded in for a height of about 3 ft. above the end sill.

Welding of Draft Sill

Fabrication of the welded draft sill is begun with subassembly of the web plates. In this subassembly operation the draft lugs are located in the proper position on the web plates by means of a locating jig. The parts are tacked together in this jig, the size of the tacks being sufficient to hold the draft lug parts in their proper

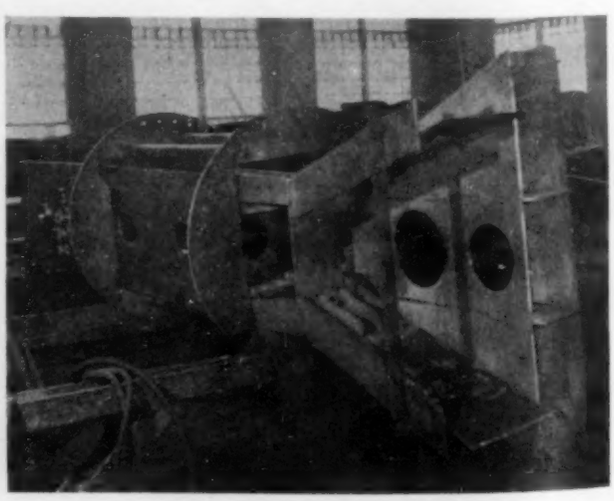


Fig. 15—Positioning of Draft Sill

location after removal from the jig for welding. The plates are removed from the jig for welding because the parts to be welded are then more accessible and the part is easily positioned manually by the welder for downhand welding.

The draft lugs transmit the entire buffing load of the draft gear into the draft sill and then to the center sill. This load is often suddenly applied and the lug attachment must withstand these impacts. The lugs are attached to the web with a double J-weld giving full penetration.

Upon completion of the draft lug welding, the web

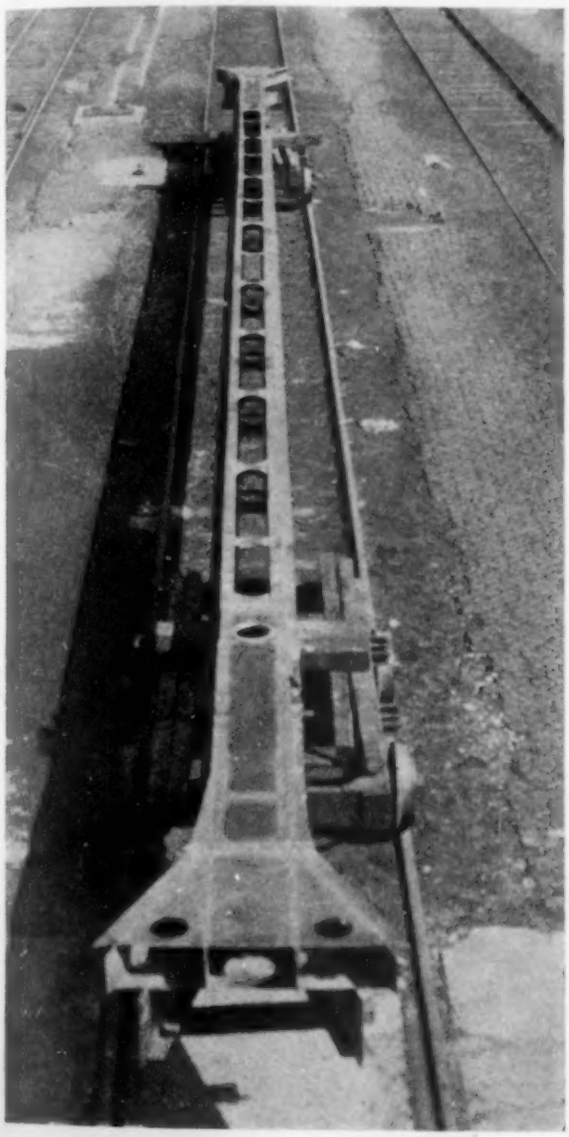


Fig. 16—Center Sills and Draft Sills Assembled

plates are assembled in a jig. The bottom flange plate, stiffener plates and bolster center filler are added in this jig. All the parts are tack welded together and the assembly then taken out of the jig so that it can more easily be positioned for welding.

Positioning of the assembly is accomplished by attaching two circular rings as shown in Fig. 15. The draft sill is easily rolled on these rings to position the welding by the welder himself. When the welding is complete the rings are removed and the top cover plate welded in place, after which the draft sill is attached to the center sill by means of a butt weld. This weld is shown in Fig. 8 and the completed center sill in Fig. 16.

Fig. 17—Center End Sill Parts and Sub-Assemblies

Welding of End Sill

The center end sill, which was formerly part of the draft sill casting, and later a separate casting, is now made up entirely from plates and rolled structural members. Some of the plates are hot pressed to form parts of the end sill. Figure 17 shows the various parts that go together to make up the center end sill. These are first tacked together in assembly jigs, and then positioned for final welding in special manipulators.

The structural channel members that stiffen the interior of the end sill are fillet welded to the bottom

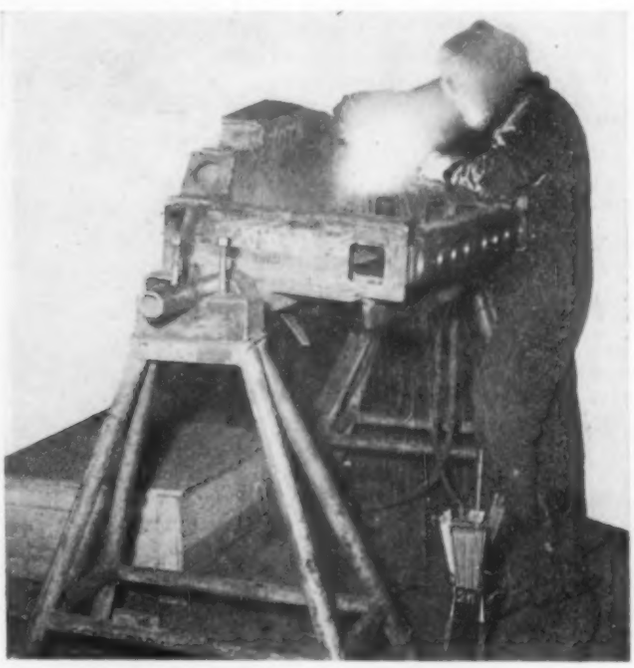


Fig. 18—Positioning Jig for Center End Sill

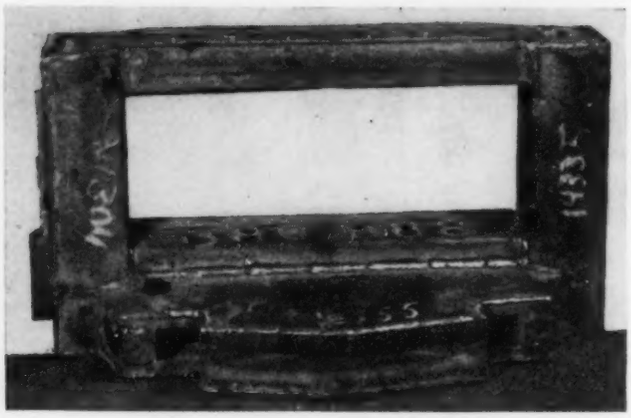


Fig. 19—Completed Center End Sill

plate and plug welded to the top cover plate. The holes for this plug welding can be seen in the plate in Fig. 17.

Positioning of the end sill, as with the draft sill, is best done with custom-built positioners. One of these is illustrated in Fig. 18. The cost of these positioners is low and they serve very satisfactorily. The parts are turned manually and held in position by a pin acting in holes in a disk which is mounted on the supporting shaft. Figure 19 shows the completed center end sill.

Assembly Into Underframe

The draft sill and center end sill are not joined together until they are assembled in the underframe jig. The draft sill is first welded to the center sill as illustrated in Fig. 8. This center sill assembly is welded to the center end sill by means of butt welds.

Savings in Cost and Weight

	Draft Sills and End Sills	Draft Gear Carrier	Center Filler	Total
Cost of casting	$1524.80	$30.24	$56.58	$1611.62
Cost of weldment	$792.02	$23.14	$14.66	$829.82
Saving by welding	$732.78	$7.10	$41.92	$781.80
Cost savings, %	48	23	74	49
Weight of casting, lb.	6395	308	560	7263
Weight of weldment, lb.	4324	286	104	4714
Saving by welding, lb.	2071	22	456	2549
Weight savings, %	32	7	81	35

During 1941, 228 cars were built in our shop. With a savings of $781.80 and weight reduction of 2549 lb. per car from the use of the above welded parts, the yearly savings would be $178,250.40 and a savings of over 290 tons of steel.

There were 548 passenger cars constructed in the United States during 1941 for domestic use. If the welded draft sill parts had been substituted for castings on each of these cars, the cost difference would have been $428,426.40 and the weight difference would have been 700 tons.

Reductions in cost and weight of from one-third to one-half is the prime reason that continuance of the arc-welding process is assured.

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(*Continued on page 334*)

Metal-Forming Machine*

By E. W. Allardt†

THIS modern and streamlined assembly of five separate machines performs a sequence of operations on flat-coiled strip steel, as follows: First, it forms the strip into a cylindrical tubular shape, then welds the edges together, then sizes or shapes the tube, then finally cuts the tube into uniform and usable lengths. The entire assembly should be considered as one machine, or at least as a unit. No one machine can be considered a complete unit in itself.

Such a unit is unique in that it is the first such material processing assembly to be so completely constructed from electric arc-welded parts, and further so in that it produces an electrically welded product.

From a total weight of 64,500 lb. for the entire assembly, 40,750 lb. or 63% of this total weight were arc-welded parts. The balance of the weight was made up of such items as cast housings, shafts, gears, bearings, adjusting screws and dials, welding transformer and non-ferrous parts for the welder, drive shafts and gearing.

It was only after careful study and design work, and after trial construction and experimenting with similar but separate machines, that this complete unit was constructed. There was no doubt, however, about the substantial savings to be effected by using arc-welded type of construction.

* First Prize Functional Machinery Award paper in the 1940–42 Industrial Progress Award Program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. The award papers showed a possible saving of $1,825,900,000, including 7,000,000 tons of steel and 153,000,000 man-hours of labor available by application of arc welding.

† Chief Engineer, Babcock & Wilcox Co., Welded Tube Div., Alliance, Ohio, formerly Chief Engineer, Yoder Co.

Description

The complete electric-weld pipe mill shown in illustrations, Figs. 1 and 2, was recently completed and contains interesting features and developments. This mill was built to produce standard pipe and tubing, in sizes from 1/2 to 3 in., inclusive, of low carbon pickled strip steel.

The mill consists of "A" a coil box, "B" forming mill, "C" electric seam welder, "D" sizing and straightening mill and "E" flying cutoff and runout table.

The appearance of the mill is very pleasing with its smooth flat base sides, its rounded corners and with almost a complete absence of projecting screw heads. Its appearance is one of ruggedness, of durability and of precise construction. Such construction and appearance make for a desire and ease of continued cleanliness and pride of work.

The coil box "A," Fig. 1, is long enough to hold two large-diameter coils of strip, the first coil paying off while the second is held in place until the first has been run out. Then the second coil is moved into its paying-off position making space for another coil, which then can be placed in its support while the preceding one is being fed to the forming mill. The side plates are adjustable for different widths of strip as required for the different sizes of tubing.

The coil box is constructed entirely of arc-welded steel plate, except for rolls, bearings and screw parts.

The tube-forming mill "B," Fig. 1, as well as the sizing and straightening mill "D," Fig. 1, are built up of indi-

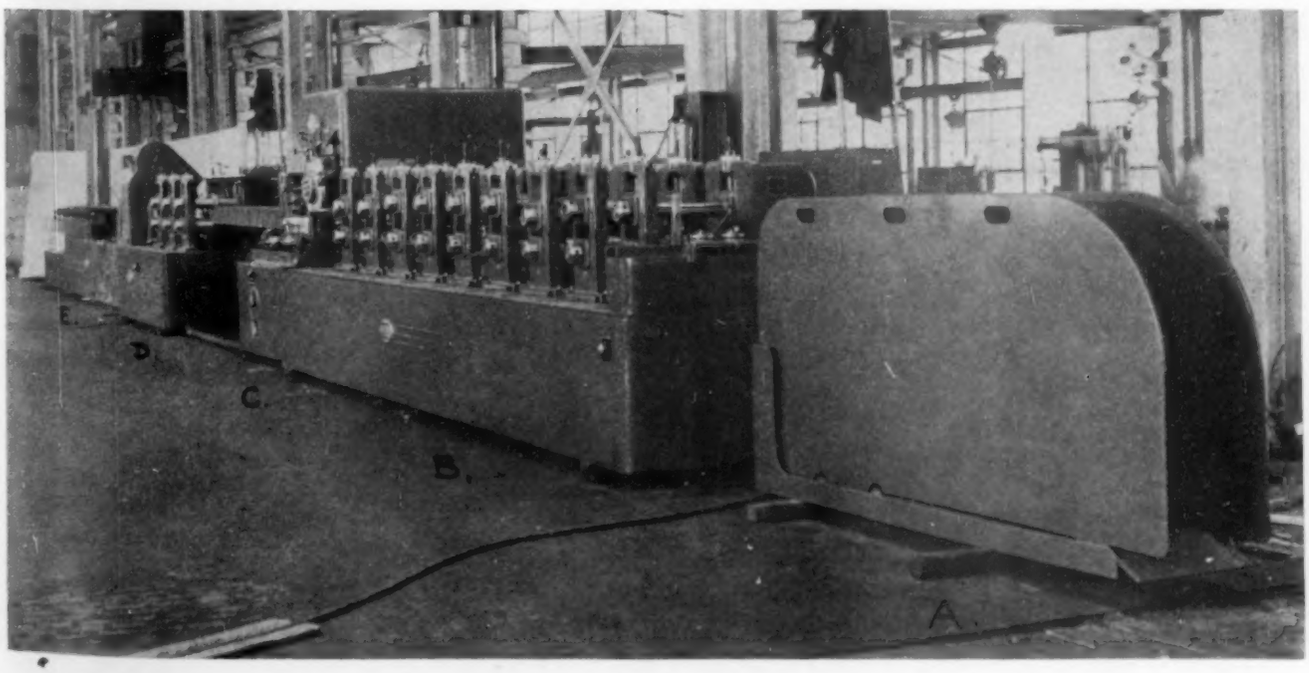


Fig. 1

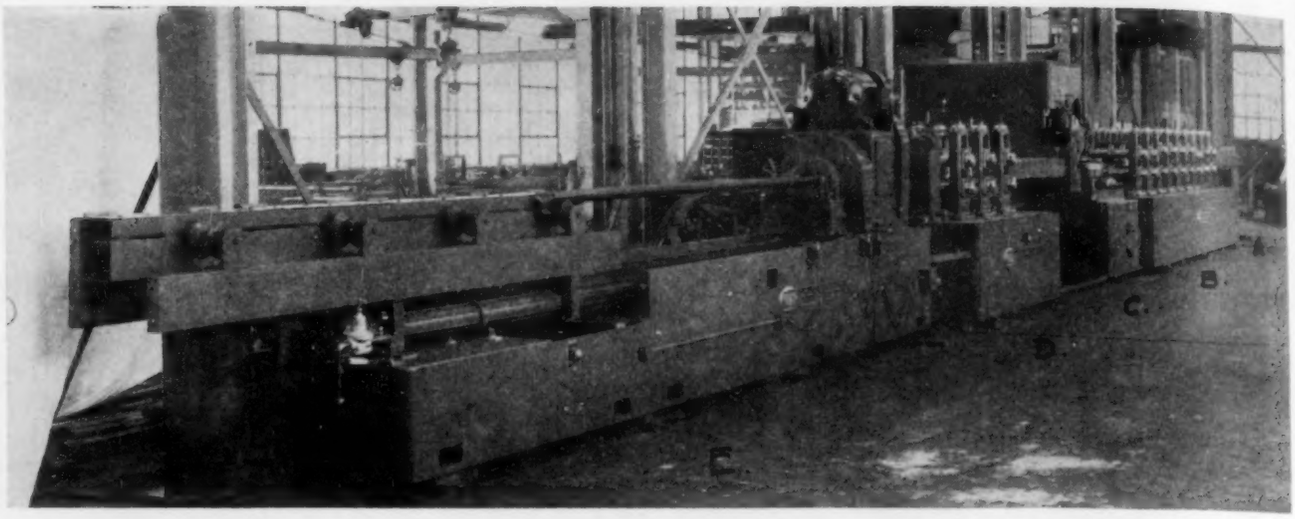


Fig. 2

vidual tube-forming roll stands, all assembled on arc-welded bases. Each roll stand is complete in itself with tapered roller bearing mounted, hardened and ground roll shafts, worm gear drive, also running on tapered roller bearings, and toggle gear drive between lower and upper roll shafts. All the gears run in a bath of oil, in dust- and oil-tight housings. The outboard housings are arranged to slide off the shaft ends after the shaft nut has been removed. Keyways are cut in bottom of housings and when machine is assembled and properly aligned then keys are inserted through keyways, then welded to base top plate. The inner races of the roller bearings in these housings serve also as a spacer to clamp the forming rolls and spacing collars into place.

The roll stands are interchangeable and are connected by couplings that are easily removable.

The upper roll-shaft adjusting screws are provided with micrometer indicators to make it possible for the operator to record roll settings for his convenience during a future setup of the same set of tube-forming rolls.

The entrance end of the mill is provided with a pair of easily adjusted edging rolls to round objectionable burrs from the slit edges of the strip and to insure that the width of the strip going into the mill and welder is held to decimal tolerances.

In the forming mill the flat strip is progressively formed, while passing through several pairs of forming rolls, into cylindrical tubular shape with edges finally butting before passing through the welding operation.

In the sizing and straightening mill, the now welded tubing passes through rolls and is reduced in size to the final micrometer dimensions and, by means of adjustable rolls, is finally straightened to commercial tolerances.

The bases for the forming and sizing mills, as well as the edging roll stand, the toggle gear housings and drive attachments are all fabricated of arc-welded steel. The design of the bases presented quite a problem to provide a smooth, unbroken exterior surface, and to make provisions for adequate water-tight drains for the soluble oil roll lubricant that must be drained to a sump for recirculation. Several design drawings were made and carefully studied and, when the design was approved, a trial base was constructed and subjected to rigidity tests. The base was found to be rigid and free from structural weaknesses.

To provide a smooth unbroken exterior for this base, the foundation bolting flanges are welded to the inside of outer walls. And because soluble oil must be copiously cascaded over the rolls, while in operation forming the tube, a drain is provided all around the finished top plate in the form of an angle as shown in enlarged section on right-hand side of sheet. The soluble oil is drained into the welded-in sump, shown in center of base, from which it is again pumped over the rolls. The top plate is welded to the angle forming the drain and is further supported by partition plates and other stiffeners in a strong and rigid manner. The key shown on the top plate serves to align the drive housings when assembled on the base.

Water tightness of the drain troughs and interior sump is very necessary for successful, trouble-free and clean operation of this mill. This has not been difficult to obtain because the well-trained welders are thoroughly competent of such construction. (Feeling that the well-trained welders properly led in group action are competent to produce very satisfactory results, drawings of such parts do not contain welding symbols which might possibly be less well understood by the draftsman making such drawings.)

A brief study of the construction of this base will disclose a saving in weight and efficiency of construction, all of which favors arc-welded steel instead of a cast base; not only because of the greater strength of steel plate but also because of the facile use of arc-welding design and practice.

The toggle gear housing was originally made of a steel casting but, because of machining difficulties due to core sand and warpage, it was finally made of arc-welded cold-rolled steel side plates and connecting members, in a jig. This construction allowed the elimination of all machining except the drilling of holes for gear shafts. This reduced the cost to one-third that of a cast part.

The main drive of the mill, not shown in photos, is from a high-starting torque motor equipped with a magnetic brake, through a variable speed drive unit having a remote electrical control. This unit is connected to the main drive shaft, that connects the forming and sizing mill, with multiple roller chain adequately protected and running in oil. A jaw clutch is provided in the drive between the mills so either can be run should occasion demand. The various drive brackets and levers are all of arc-welded steel.

Next in line is the seam welder "C" in Figs. 1 and 2. In this unit the base and its separate top plate, transformer supports, the cover over-all of the rotating parts, roll housings, water-cooling connections and various brackets are all made up of plate, or bars, in suitable arc-welded assemblies.

Various parts such as auto-transformer, contactor panel and tap switch are mounted in the base. To facilitate assembly, the top plate of the base is separate and bolted to the upper reinforced rim of the base. To the underside of this top plate are bolted the transformer assembly elevator screw drive and motor, and to the top side are bolted the transformer assembly, welding rolls, outside bead trimmer and other machine parts.

In this machine the rotating copper alloy electrodes contact the opposite sides of the seam to resistively heat the edges to welding temperature. The welding rolls on both sides of the tubing and below the electrodes exert forging pressure to the hot seam and hold it during the almost immediate freezing of the metal. The welder and mill controls, mounted in an arc-welded box, are within easy reach of the operator.

Then last in line, "E" in Figs. 1 and 2, are the flying cutoff and its runout table with side discharge, practically all constructed of arc-welded steel. The cut-off machine is a recent development and is entirely automatic in its operation. The tube passing through the center core of the arc-welded steel cutting head and onto the arc-welded steel runout table, strikes a switch, adjustably mounted along the runout table, which causes the carriage holding-latch to be released, allowing the counterweighted carriage assembly to move forward with the tubing. At the instant that the carriage starts its forward movement the gripping chucks, also of welded-steel construction, operate to hold the tubing rigidly, while at the following instant the cutters move inwardly to make the cut.

The hollow arc-welded cutting head rotates on tapered roller bearings in its arc-welded steel housing, and together with the enclosed cutter actuating mechanism, is oil-bath lubricated.

After the cut has been made the cutters retract, at which instant a switch is operated to cause the solenoid air valve to function the air cylinder which returns the cutter head carriage and chuck assembly to its latched starting position. The cut piece of tubing continues on its way down the live roller table until it strikes a switch, which causes the side discharge arms to deposit the tube onto a truck.

Because the large and long-stroke air cylinder requires a considerable volume of air, an air-storage tank is welded into cut-off base and carefully reinforced with welded-in tie rods, and tested to 1500-lb. hydrostatic pressure. This tank is shown in Fig. 2 at reducing-valve end of base.

In a flying cutoff of this type it is imperative that the weights of all moving parts, particularly those that must be quickly accelerated, be made as light as possible and yet strong enough to stand the severe service. This elimination of weight helps reduce any operating inertia, and provides for considerable increase in operating speeds. Arc-welded steel construction meets this condition very satisfactorily and economically.

The counterweight column and its parts shown at end of cutoff, in Fig. 2, are also fabricated of arc-welded steel.

Decision Factors

The factors which led to decisions to build this tube mill so completely of arc-welded steel were:

1. Cost saving which includes:
   (*a*) Economy of materials (weight saving, 49.5%).
   (*b*) Economy of production (61%).
2. Time saving (64%).
3. Facility of production.
4. Durability.

Facility of Production

The facility of arc-welded construction is so apparent that it hardly seems necessary to mention it. Some of the foregoing remarks apply to the facility but probably one other comes to mind. During the construction of a mill as herein described, minor changes, due to errors, may become necessary. These errors are easily corrected with dispatch and usually without the time necessary to disassemble, as might be the case with cast structures. And furthermore, improvements thought of during construction and assembly can and are made without the necessity of pattern changes and new castings, simply by fabrication done quickly on the job. The importance and value of such facility are quickly accepted by all workmen concerned and seem to engender suggestions for improvements and help to speed up the final construction, instead of hindering it.

Durability

The durability of such arc-welded equipment is beyond dispute. In older types of similar construction it was not uncommon to have a customer report parts, bases, legs, brackets, covers and other parts broken in transit or during operation of equipment. Since the adoption of arc-welded construction such complaints have entirely disappeared.

It is necessary in mills of this sort that there be no warpage or deflection that would cause rolls and other accessory parts to become misaligned. These mills are entirely free from such trouble. Some of these bases have lubricant reservoirs welded in, others have soluble oil sumps or tanks welded in as part of the structure, others have air tanks, adequately reinforced, built in as a necessity for the successful operation. In all of such instances no trouble or leakage has been encountered even though such parts have been subjected to long hauls and shipment.

Many of the bases above mentioned are not normalized, but have peened welds for the purpose of counteracting the natural deflections from heat of welds. Housings of welded steel where alignment of roller bearing mounted shafts and parts are included are usually normalized to insure stability of the structure.

Welded Display Holder for Printed Matter*

By Victor Paul Weidner†

Foreword

THE subject described in this paper is a welded metal holder which is used to display printed matter. This type has successfully replaced previous designs fabricated from wood and plastic materials.

Prior to 1940, these holders were made of wood but were considered unsatisfactory because of their high upkeep. To replace these, the author substituted a new design to be molded from plastic, hoping that this type would be a better solution, but the experiment was not quite feasible. Further research was carried on which resulted in the design of a metal holder. This last type has been selected as the subject of this paper.

During the period in which the final design was under consideration, it was discovered that curving the front faces of the holder helped to stiffen the printed matter which heretofore had had the tendency to droop at the top, thus hiding its caption line or title. This drooping effect had been caused by the action of humid weather on the paper stock or after being displayed for a short period of time.

Ten test models were fabricated for our exhibits at the 1940 New York World's Fair, where they were subjected to every kind of hard service. These models were made of sheet brass with brazed joints and were chromium plated for show purposes. This model proved too expensive to make up in large quantities, therefore it was decided to use sheet steel. As this holder was to be the first metal-type equipment to be installed on the counters in the company's branch offices, its appearance was an important factor. All joints had to be neat and clean looking and no hazards were to be reckoned with under usage by our customers. Welded seams ground off smooth or to a small radius were then specified on the drawings. The design has been standardized for general use and is stocked at our company warehouses throughout the country.

Further Uses

This display holder, while primarily designed for the use of telegraphic blanks, can also be used for the display of other types of printed matter, such as railroad timetables, air transport schedules, hotel reservations and for sales information for department stores.

If built in size on a somewhat larger scale, current issues of magazines, tabloid newspapers, sheet music and similar items could be displayed in a neat upright manner without the wilted-flower effect so many of them get after on display for a short period of time.

Conclusion

Our company has found that the process of arc welding has assisted our work in the following ways:

Fig. 1—Welded Type

1. It has helped us create a well-styled commodity that has enhanced the display of our advertising matter.
2. It has helped keep this material in good shape for a longer time than the older types of holder, thus saving some money when we discarded decrepit-looking matter.
3. It has been a vital factor in lowering the cost of the holders and yet at the same time making them more durable.
4. It has helped eliminate those small personal hazards of splinters and scratches which have always been so objectional from our customers' viewpoint.

* Third prize paper in Furniture and Office Fixtures division of 1940–42 Industrial Progress Award Program sponsored by The James F. Lincoln Arc Welding Foundations, Cleveland, Ohio. The award papers showed a possible saving of $1,825,000,000, including 7,000,000 tons of steel and 153,000,000 man-hours of labor available by application of arc welding.

† Engineer, The Western Union Telegraph Co., New York, N. Y.

Description of Welded Construction Used in a Thread Miller Bed for Milling Propeller Blades*

By P. W. Martin†

THERE has been a great deal of discussion for and against steel beds for machine tools. Some claim that the fabricated beds vibrate, causing chatter and noise, and also that they are not rigid enough to hold their shape and spring under the load. Another claim which has been made is that they do not retain their shape. This latter point is very important, particularly in a precision machine for if distortion occurs through seasoning, it is thrown out of line.

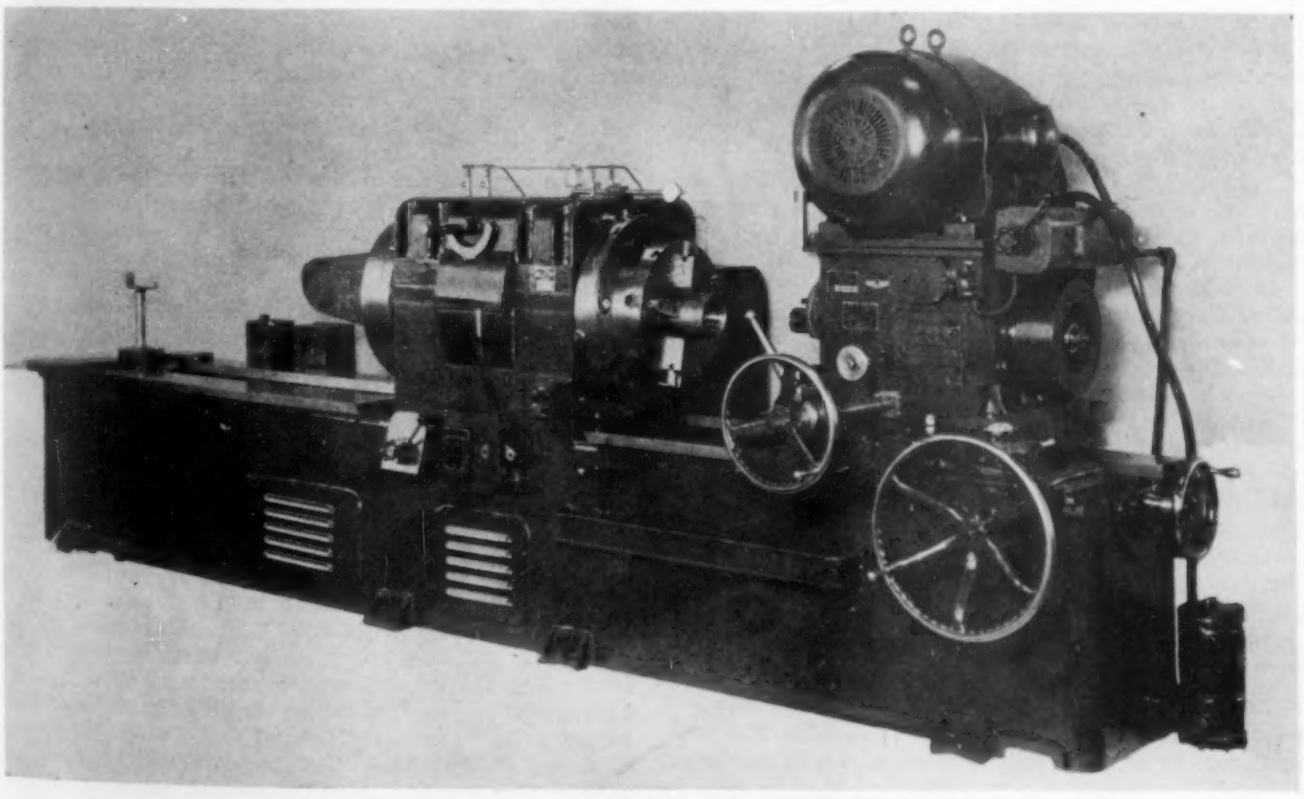
On the other hand many claim that the steel beds are lighter, stronger and do not distort through seasoning. It is also claimed that they are amply rigid and are not subject to cracking which sometimes occurs in a cast-iron bed. A cast-iron bed will sometimes crack in heat treatment and they have been known to crack after they have come from the foundry before heat treatment. Internal stresses are sometimes caused by uncovering the castings improperly or removing them from the sand too soon.

Another difficulty encountered in cast-iron beds is in obtaining the proper mixture. There is a popular demand at the present time for close-grained hard iron. This iron takes a higher polish than the old open grain iron and the hardness gives it longer wearing qualities. The thickness of a casting usually varies considerably in different parts. In many places the wall can be much thinner than in other places and these mixtures of hard iron are liable to chill and become very hard and brittle at the thinner points when the hardness is just about as desired at the heavier points. In a machine with moving members the ways are usually heavy, while some of the other parts of the bed can be of much lighter section. The result is, if considerable care is not taken, the lighter sections which have some machined surfaces are too hard and brittle to be worked.

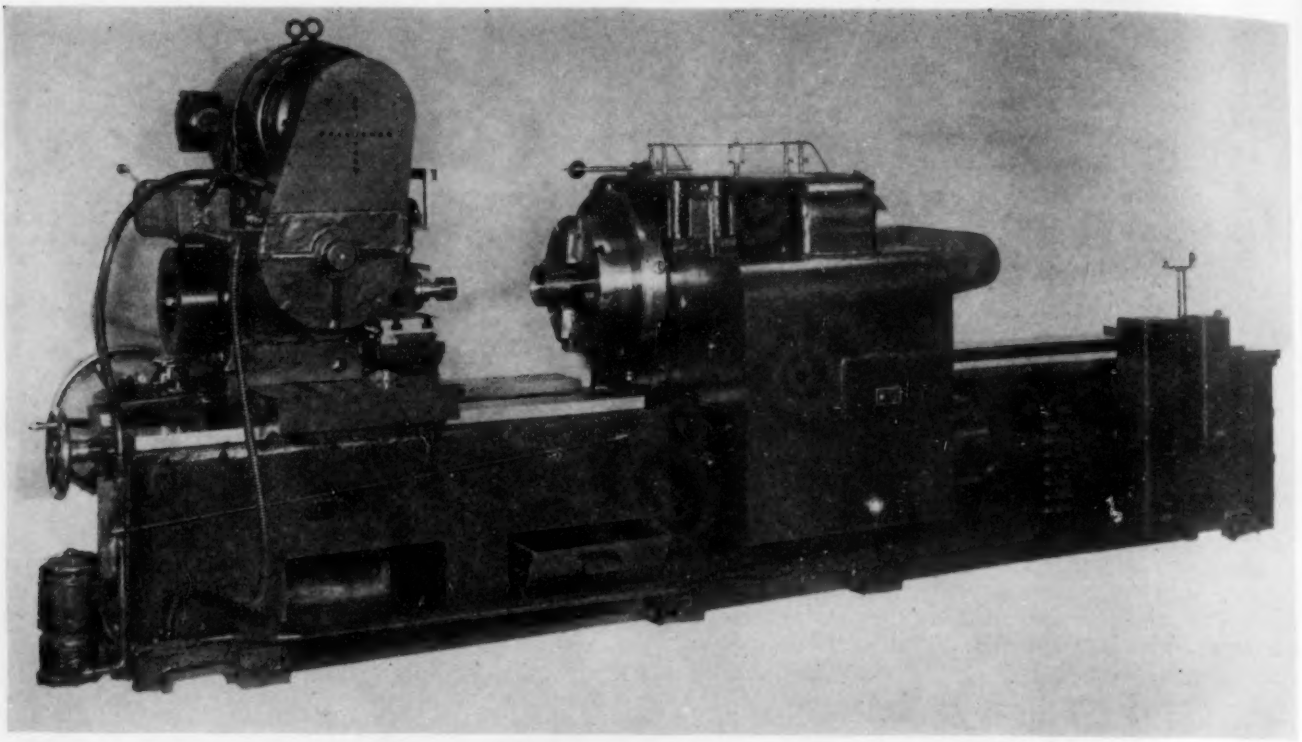
Another point about a cast-iron bed, which is by no means always present, is the difficulty of obtaining the desired shape due to intricate coring. In a fabricated

* Third Prize Award paper in the Functional Machinery Section of the 1940-42 Industrial Progress Award Program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. The award papers showed a possible saving of $1,825,000,000, including 7,000,000 tons of steel and 153,000,000 man-hours of labor available by application of arc welding.

† Secretary and Chief Engineer, Smalley General Co. Bay City, Mich.



Front View of Thread Miller with Propeller Blade in Place



Rear View of Thread Miller with Propeller Blade in Place

bed this can usually be obtained much easier and there is no liability of loss as in a casting. Another advantage of a steel bed is that it has greater strength and therefore is not subject to breakage.

It is a well-known fact that cast iron has a tendency to dampen vibration. It also has a tendency to wear better than soft steel and has less tendency to cut. This being the case it is comparatively easy to provide cast-iron ways for a bed by bolting them to a steel foundation. This has an added advantage over the cast-iron bed in the fact that the ways can be renewed when worn or badly cut.

A short time ago we received a contract for several special Thread Millers. These were for the purpose of milling propeller blades, and not only did they have to have a large diameter spindle but they had to have ways on each side of the main spindle bearing. On one side our milling head operated and the other side was used to true up the opposite end of the propeller blade so that it would rotate on its true axis. These ways had to be in line.

There are several features of this machine which are quite different from our standard machine on which we have been using cast-iron beds. One of the principal differences was the large diameter hollow spindle. After considering the matter from various angles we decided to use a steel bed. We could get that quicker, and that was an important element. Also we figured that, for the limited number at any rate, we would save expense because of the saving in the cost of the pattern, boxes, etc. We therefore worked up the design which is shown in the photographs of the finished machine.

We decided to use half-inch plates in the sides of the machine and as we wanted these to remain at a constant width we cast steel bearings for the spindle and used them for separators. The bearings were machined before placing them in the bed leaving $^1/_{16}$ of an inch on the bore and on the end for finish after welding together. This machine work was much easier to perform on the boring mill than after the bearings were welded in place. We made a mandril which secured the two castings with the proper spacing and prevented their shifting in welding. Wings were provided on each casting which, on being finished, made the proper spaces for the side plates and also braces for the bed. The castings were then, of course, solidly welded into the structure. On the right end of the bed the milling head was mounted and therefore this end had to be very rigid. In thread milling we get severe side thrusts as well as down thrusts and also a tendency to vibrate or chatter due to the intermittent action of the cutter. We therefore decided to place two $1^1/_2$-in. strips along the top of both extensions and these would afterward be planed off and the ways bolted to them. Between these ways we needed a trough to catch the coolant and chips and direct them to a pan down underneath. We therefore placed heavy separator plates at 18-in. intervals in the right-hand section and they extended clear to the bottom in some cases and part way down in others. These not only provided a series of braces but broke the side plates up into small square sections thus reducing the liability to vibrate. These plates were cut out with a U-shape gap in the center which formed the base for the trough and thus they were permitted to run up to the under side of the top plates so they could be welded to them. A U-plate was then placed in the trough but the edge did not come up to the top plate but left a space of approximately $2^1/_2$ in. between the top plate and the top edge of the trough. This was to permit access to the bolts which were used to hold the ways in place. They will be mentioned later. On the bottom of the right-hand end was placed a plate which formed a pan into which the coolant was directed and stroed. The rear side plate had two arched openings cut in it to give access to the pan for cleaning, and the edges of the bottom plate were bent up on an angle of 45° to a height of $4^1/_2$ in. At the clean-out points there were lips placed on the outside of the pan so as to enable the helper

to place the pan under the lip and prevent the oil dripping on the floor. Running down from the bottom of the trough was a chute. Under this chute and level with the top of the pan were placed two angle slides. These carried a pan 4 in. deep. The pan was punched full of 1/16-in. holes to permit the coolant to run out but to retain the chips. This arrangement permitted the helper to draw the pan out and dump it. It also prevented the necessity of cleaning out the bottom of the pan at frequent intervals. The plate under the right-hand end of the main bearing went clear to the bottom thus tying the whole bed together and forming the end of the pan.

On the left-hand end of the bed we put the same top plates, but as it was not necessary to have the same rigidity there, we cut away the back plate and thereby provided an opening into which a 7 1/2-hp. four-speed motor could be inserted. This opening was tied together at the top and bottom and a tilting base was placed inside for the support of the motor so it could be adjusted to tighten the belt. There was also an opening in the front plate to provide accessibility to the screws which operated the tilt of the table. A shallow trough was placed between the ways at this end with a sump up against the bearing which drained into the pan at the other end. At the extreme left end a door was provided which gave a small storage space for tools.

Between the two end plates under the bearings was placed a tilted plate This was welded in tight and a hole placed flush with the plate so that the drip from the bearings would run down into the pan. This prevented the oil from getting onto the floor. There were two other openings placed beneath this drain plate. One for the reception of the pole changing switch and the coolant pump switch inside. The other hole was to enable the electricians to wire the motor. Louvre covers were placed over all the openings. Around the bottom of the bed were welded steel feet. These were provided with holes for anchor bolts and leveling screws. The feet were placed below the pan so that in planing we did not have to carry the cut all the way across the bottom but simply along the lines of the feet.

The main spindle was driven by a train of gearing which was mounted in a fabricated gear box. This box was placed on the back of the machine after assembling. The power shaft came through the end plate of the box so that the V-belt sheave could be placed thereon and be driven by an inclined belt from the motor. The gear box was made up of steel because a cast-iron box would require rather complicated coring.

In machining this bed we turned it on its side and planed off the feet. We then turned it right side up and planed off the retention for the caps on the steel bearings. That gave us a starting point for the distance of 15 in. from the center of the bearing to the upper surface of the top plates These were then planed off using a shear tool for the finishing cut. This left a smooth surface for scraping. The edge of the opening which had been formed by welding in 1/2 by 1-in. bars were then planed off as were also the strips welded on the back for the reception of the gear box. The bed was then sent to the horizontal boring and milling machine to finish the extreme right-and left-hand ends. Extreme care was taken to get the proper line-up between the right- and left-hand ends. The top plates were then scraped into surface plates and the top plates drilled with a jig. In planing these we cut a 1/2 by 1/4-in. keyway down the full length of the top plates.

The cast-iron ways which were 1 1/2 in. thick made of a hard close-grained iron had been previously planed to size and scraped The bottoms of the plates were then drilled with blind holes and tapped. Then we placed studs in the ways and a key in the center where there was a keyway to match the one in the bed. Next the ways were bolted down. The opening which had been left between the top edge of the trough plate and the bottom of the top plate permitted the assemblers to reach the nuts that were placed on the studs. On applying the face plate to the top of the ways it was found that there was very little work necessary to true them up. In fact the time required to scrape and assemble the ways on the bed was not as long as that required to scrape in a similar cast-iron bed.

The greatest inaccuracy of such an operation is in the bed itself and with a steel bed the distortion due to seasoning was less than the distortion in a cast-iron bed and the steel bed was softer and could be worked faster.

It is necessary, of course, to heat treat both steel and cast-iron beds before finish machining to relieve the internal stresses which later cause distortion if not removed. The bed was then taken to the boring mill for the boring operation. There the 1/16 in. which was left for finish was removed, thereby insuring perfect alignment and proper size. The ends were also faced.

In handling the bed for these various operations after scraping there is a liability that the bed will spring out of line if not sufficiently rigid. When the bed was brought back to the assembly floor we found that it was absolutely in line. We had been warned by some that unless we gave it a second heat treatment after rough machining it would distort and get out of line in handling. After putting in the bronze bushings we handled it again with slings and still had no difficulty.

On completion and test we found that the steel bed functioned perfectly. There was absolutely no vibration or noise and on examining the threads produced there was no unusual spring. We took exceptionally heavy cuts with the form milling cutter with the same results stated above.

The weight of the steel bed before machining was 4500 lb. It was 16 ft. 2 in. long and 2 ft. 4 in. wide.

In planning the cutting of the steel the side plates were cut 26 in. wide so that the weld with the bottom plate was on the bottom and did not show. In the center at the bearings an extra plate 16 3/4 in. wide was welded onto the side plate to cover the upper part. This was more economical in cutting than it would have been to make it all of one plate 43 1/4 in. wide. The side plate was beveled so that we had a good weld after grinding smooth. The side plates were rounded at the end corners and the end plates welded in between. The heavier cross plates were flame cut and their width maintained very exactly. We had a cutting machine for this work.

The cost of the steel bed was as follows:

Welded bed 4500 lb., including heat treatment	$ 893.00
Two bearing castings, bottom half, 352 lb. at $0.12 per lb.	41.64
Machining castings, 20 hr. at $2.50 per hr.	50.00
Planing, 60 hr. at $4.00 per hr.	240.00
Four ways, 1483 lb. at $0.11 per lb.	163.13
Planing ways ready for scraping, 26 hr. at $4.00	104.00
Drill and tap ways, 3 hr. at $2.00	6.00
Scrape bed drill and fit ways, 60 hr. at $2.00	120.00
Final scrape after attaching ways, 10 hr. at $2.00	$ 20.00
	$1637.77

In welding it was possible to keep the bed very straight so we were not bothered in machining it.

This steel bed had several advantages over the cast-iron bed. First, the ways are renewable. If in time

these machines get badly scored or require truing up, due to wear, new ways can be put on them Or, if this wear is not too much, a $^1/_{16}$-in. shim of steel can be placed under them thus raising the ways and they can then be planed off to the same height they formerly were and be scraped. Furthermore the bed is much stronger than the cast-iron bed. In handling the machines in the plant where they were installed, they placed slings through the oval holes provided at each end and picked up the machine. When the riggers did this they questioned whether it would be safe to pick it up by the end in that manner. The machine was very quickly handled in this way and did not spring. Later they raised the machine by placing slings in the recesses provided for jacks and raised it with one hook. They were again skeptical as they had been handling some other cast-iron beds of equal length and they had to space slings very differently. The fact that the beds had not sprung in any way was shown by the fact that they leveled up very easily and accurately.

Saving Steamboat Propellers from the Scrap Heap*

By H. C. Elliott†

HERE is a method used by the Mississippi Valley Barge Line Co. of Cincinnati, Ohio for saving damaged river steamboat propellers from a scrap heap death.

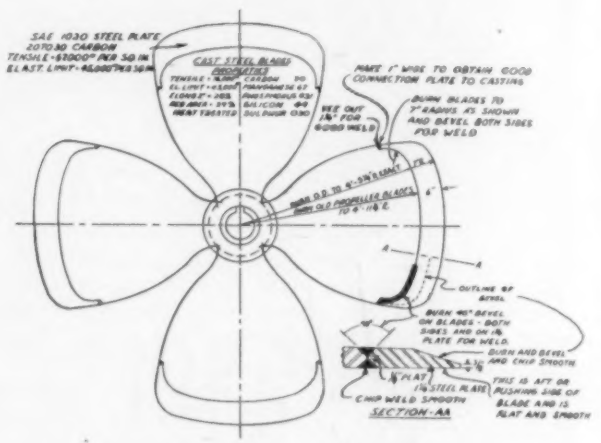
Pitting of cast steel propeller blades is a common trouble on the rivers. This is found especially on the forward side well out on the diameter. For example, on three pair of our propellers, the outer 6 in. of the blades sometimes become pitted all the way through them which destroy their efficiency and cause excessive vibration.

This pitting is probably due to "cavitation," a term used to describe the formation of cavities in the water forward of the propeller blades. These cavities are thought to be filled with air and water vapor. The bursting of these cavities causes a pitting action on the cast steel propeller blades.

The speed of river boats average 7 m.p.h. whereas a propeller having a 5-ft. pitch, turning 210 r.p.m., should move the boat and tow at 12 m.p.h. Resistance of the tow ahead of the boat reduces the speed of the boat from the theoretical 12 m.p.h. to 7 m.p.h. or the propeller has a "slip" of 5 m.p.h. This slip causes a difference in pressure on the two sides of the blades and results in "cavitation."

The thickness of cast steel blades is another possible cause of "cavitation." Edges of cast steel propeller blades have to be made at least 1 in. thick at the cutting edge, for if made thinner the edges would become battered and pitted in a few weeks of use. But cast steel blades, repaired with welded steel plate, as shown in the drawing, can be sharpened to a $^3/_8$-in. thick edge. This makes cutting the water easier and eliminates to a great extent the forming of "cavitation" on the forward side of the blades.

For the welded repair of a propeller, the damaged edges are burned off at a true radius of about 6 in. beveled on both sides. Next, a cardboard templet is


SAE 1030 STEEL PLATE
CAST STEEL BLADE
MAKE 1" WIDE TO OBTAIN GOOD CONNECTION PLATE TO CASTING
BURN BLADES TO 7" RADIUS AS SHOWN AND BEVEL BOTH SIDES FOR WELD
SECTION-AA

made to replace the burnt off area plus an inch on the O.D. for trimming off after welding.

Pieces of $1^1/_4$-in. steel plate were cut out following the templet pattern and both sides beveled. These pieces were clamped into position to the cast steel blades and welded with ordinary $^1/_4$-in. diameter electrodes (mild steel electrodes).

After completion of welding, the correct diameter of the wheel was laid off with a marking arm pivoting at hub center. At the outer end of the arm was a bearing for a pointed rod to slide up and down to follow the "twist" of the blades. With this tool, an accurate line was scribed at exactly 4 ft. $5^1/_4$-in. radius and the $1^1/_4$-in. plates burned to that line. This procedure produced an 8 ft. $10^1/_2$-in. diameter propeller.

The outer edges of the repaired propeller were then beveled on the forward side only with a cutting torch. The edges were beveled back 3 in. and down to $^3/_8$in. thick at the "cutting" edge and then the bevels and welds smoothed up with a chipping hammer and grinder.

The propellers were then set up on "vee" blocks with a short shaft through the hub. The blades were balanced by tacking on several blocks of steel as weights (previously weighed) and then chipping off metal opposite those weights until the wheel would rotate and stop at any place with not over half a pound of weight blocks left anywhere on the blades. This is almost perfect balance for propellers of this size. Operating at 210 r.p.m. they will rotate entirely free from vibration.

Total cost, including 100% overhead, for repairing one pair of propellers by welding was $346.40. Cost of a new pair of cast steel propellers is $2200. The welded propellers give performance exactly equal to new cast steel propellers plus the elimination of any troubles caused by pitting of the outer edges of the blades.

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* Drawing, courtesy Hobart Brothers Co., Troy, Ohio. A winner in Hobart's monthly Arc Welding News Contest.

† Mississippi Valley Barge Line Co., Cincinnati, Ohio.

Developments in the Design of Storage Water Heaters*

By S. Arnold Smith†

THE design and production of heat exchangers and pressure vessels has been simplified and improved by the use of arc welding. Not only has it enabled the designing engineer to use a lighter weight of raw materials, to produce a better product than was possible with previous methods of construction, but it opens up an almost unlimited field for types of construction which were practically impossible before the advent of welding. In designing heat exchangers, the engineer is confronted with the problems involved in designing for safe internal working pressures varying from vacuum conditions to pressures of 2000 psi. or more; for temperatures ranging from 200° F. or lower below zero to 1000° F. or higher above zero; and for corrosive conditions requiring the use of almost every material capable of being formed and welded. The construction involved is frequently of such a nature that the old methods of fabrication by means of castings and riveted designs are practically out of the question, either by virtue of excessive cost or of the difficulties of producing a satisfactorily finished product. Areas exposed to high operating pressure should be designed as compact as possible to reduce the total pressure area, thus holding the total pressure load to a minimum. Parts subjected to wide variations in temperature should be as flexible as possible. For these and many other conditions, welding is now an indispensable tool in the hands of the designer and manufacturer of heat exchange equipment. In this paper, it is proposed to touch very briefly on the general subject of heat exchangers, their use and application, and, selecting one regularly manufactured piece of equipment, point out the differences in design necessary in changing from riveted to welded construction and the benefits resulting therefrom.

What Are Heat Exchangers?

The name is really self-explanatory. Heat exchangers are used to effect the transfer of heat from any liquid, gas or vapor to another of these media. A tubular heat exchanger consists, essentially, of a number of relatively small sized tubes enclosed in a shell or casing, with means provided to keep the two fluids entirely separate from each other with absolutely no interleakage and, at the same time, comply with the factors involved in the efficient design of such equipment, namely, relatively high velocities to increase the rate at which heat is transferred from the one fluid to the other, and relatively low pressure losses to reduce pumping costs and loss of head pressure.

Large numbers of heat exchangers are used in the oil refining and chemical industries, in central power stations and in the food industry. In fact, they appear in some shape or form in almost every industry and most large buildings.

In some cases, exchangers are used simply to get rid of unwanted heat. For instance, it is necessary to remove the heat, generated by friction, from lubricating oil circulated to large bearings in turbines, generators and prime movers in general. In heat treating steel plants, heat from the quenching oil generated by quenching quantities of steel from temperatures of about 1600° F. must be removed. In internal combustion engines, the jackets must be kept cool, otherwise the engine would be quickly overheated and ruined. The life of the engine is greatly prolonged by using clean or preferably distilled, cooling water, and the heat absorbed by the jacket water is removed by circulating it through a water-cooled heat exchanger, using any available supply of cooling water. These are all examples of unwanted heat, and while in some cases the heat can be transferred to some other fluid and used to advantage, the conditions are such that it is usually more practical to transfer it to a suitable source of cooling water and discharge it to waste.

Another example of unwanted heat occurs in distillation processes where the latent heat of steam or vapors must be removed to condense, or reduce to the liquid phase, the products of distillation. Frequently, a part of this latent heat is used to economic advantage in preheating the cold feed to the evaporator, or to vaporize other liquids which can be evaporated at a

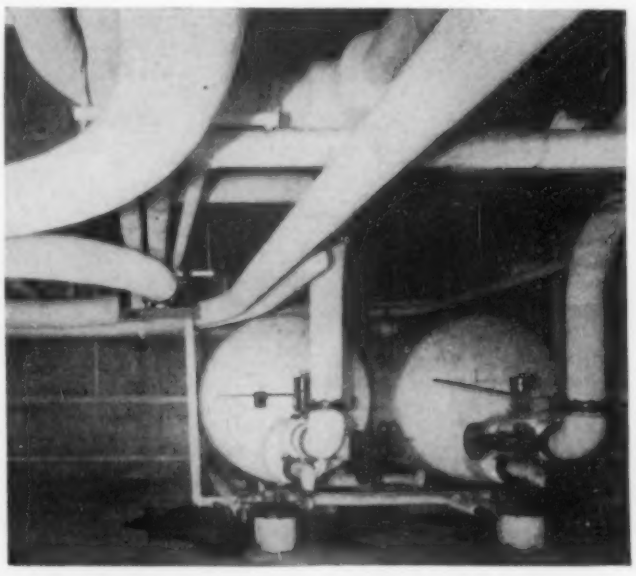

Fig. 1—Storage Heater Installation in a Hospital

* Fourth Prize Award paper in Classification H of the 1940–42 Industrial Progress Award Program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. The award papers showed a possible saving of $1,825,000,000, including 7,000,000 tons of steel and 153,000,000 man-hours of labor available by application of arc welding.

† Chief Engineer, The Whitlock Manufacturing Co., Hartford, Conn.

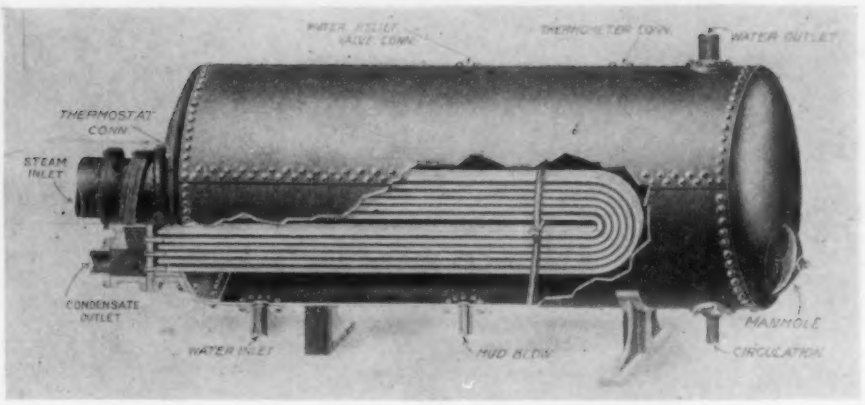

Fig. 2—Riveted Storage Heater as Originally Built, with Cut Away View Showing Detail of Steam Chamber, Heating Element and Cast Iron Head Port

temperature lower than that of the vapors being condensed. After recovering all the latent heat which can be used in this manner, in a specially designed heat exchanger or condenser, the balance is removed in a vapor condenser. It is frequently desirable to cool the condensed products from the condensing temperature to approximately room temperature, and this is accomplished either by making special provisions for condensate cooling in the vapor condenser itself or by subcooling the condensate in a separate liquid cooled heat exchanger.

In central power stations, steam is generated at high pressures and expanded through a turbine, and a portion of the heat energy therein is converted into useful work. A small percentage of this steam is "bled" at several points from the main turbine and used to preheat the condensate stream to a relatively high temperature before its return to the boilers. However, after expanding the steam to the lowest practicable pressure, the latent heat still remaining must be removed by means of a water-cooled condenser so that the necessary vacuum may be obtained, and the condensate recovered to be returned again to the boilers. All heat rejected to the cooling water must be considered as lost.

The amount of fuel used, either directly or indirectly, by the nation's industries, to generate heat which must subsequently be gotten rid of, is very large and constitutes a considerable drain on our natural resources. However, engineers, scientists and others engaged in the design and maintenance of industrial plants are fully aware of this fact, and the use of heat exchangers is rapidly increasing wherever they can be used to economic advantage.

For instance, in the oil refining industries, a great deal of the heat generated from fuel is recovered and used again by the efficient location of heat exchangers in the various fluid streams to transfer heat from one fluid to another. Hot liquids or vapors are passed through one circuit of a heat exchanger, heating or vaporizing another liquid entering the other circuit at a lower temperature.

Textile plants and laundries are large users of hot water at temperatures ranging up to 200° F. or higher. Having served its purpose, the water is of no further value and is rejected to waste. In this case, it is not only practical but highly economical to recover a large percentage of the heat content of the waste water and transfer it to the incoming fresh water. This is accomplished by a special form of heat exchanger known as a preheater or heat reclaimer. An installation of this type reduces the fuel consumption of the entire plant, representing not only a saving in dollars and cents to the owners but a worth-while contribution to the conservation of our natural resources.

Instantaneous and Storage Heaters

One of the simpler, but by no means less important, forms of heat exchangers is that used in the transfer of heat from steam to water for the production of hot water for various industrial and domestic purposes. Such heaters may be divided into two separate groups, instantaneous and storage. Instantaneous heaters are used when the demand for hot water is fairly uniform and steady, for instance, in heating turbine condensate in central power stations, recirculating water in swimming pools, keeping overhead sprinkler tanks above the freezing temperature and for supplying hot water radiation to large buildings, using steam from the low pressure boilers.

In cases where the hot water demand is irregular, the storage type of heater is desirable and much more economical to operate. Such conditions occur in hotels, schools, hospitals, institutions, industrial buildings, etc., where hot water is needed for showers, lavatories and general purposes; in laundries, where large quantities of hot water are required in the laundering of clothes; and in textile mills, bleacheries, dye houses, meat packing houses, etc., some of which use large quantities of hot water with an uneven demand rate.

The principle involved in the design of a storage heater is to provide ample storage capacity to supply sudden hot water demands and to porportion the arrangement and amount of heat transfer surface to produce the required amounts of hot water so that steam for heating the water will be drawn from the boiler at a fairly uniform rate without violent fluctuations. This requires a rather carefully detailed study of the requirements of each installation. A storage heater to be installed in a hotel, for instance, will be required to supply hot water at, say, 180° F. for a known number of shower heads, hot water faucets and other demand points. The amount of hot water which these fixtures may be

Fig. 3—Completed Storage Heater—All-Welded Design

Table 1—Hot Water Fixture Capacity for Various Types of Buildings

Figured at a final temperature of 180° F. Gallons of water per hour per fixture.

	Apartment house	Club	Gymnasium	Hospital	Hotel	Industrial plant	Office building	Public bath	Private residence	School	Y. M. C. A.
Basins, private lavatory	2	2	2	2	2	2	2	2	2	2	2
Basins, public lavatory	4	6	8	6	8	12	6	12	..	15	8
Bathtubs	20	20	30	20	20	30	..	45	20	..	30
Dishwashers	15	50–150	..	50–150	50–200	20–100	..	..	15	20–100	20–100
Foot basins	3	3	12	3	3	12	..	..	3	3	12
Kitchen sink	10	20	..	20	20	20	..	..	10	10	20
Laundry, stationary tubs	20	28	..	28	28	..	..	..	20	..	28
Pantry sink	5	10	..	10	10	..	..	..	5	10	10
Showers	75	150	225	75	75	225	..	225	75	225	225
Slop sink	20	20	..	20	30	20	15	15	15	20	20
Hourly heating capacity factor	30%	30%	40%	25%	25%	40%	30%	50%	30%	40%	40%
Storage capacity factor	125%	90%	100%	60%	80%	100%	200%	120%	70%	100%	100%

expected to draw is fairly well established and, as a matter of interest, is included in Table 1. Of course, it is very unlikely that all of these fixtures would be in use at any one time so that after listing the fixtures and totaling the theoretical amount of hot water required, this total is reduced by applying a percentage "use" factor, also indicated in Table 1, which has been proved by experience to be conservative. This then gives us a reasonably close approximation of the *rate* at which hot water must be produced to satisfy the requirements, and knowing the steam pressure which will be used as a heating medium, the amount of heating surface and its proper arrangement to produce these results are readily determined by the designer.

The hot water storage capacity necessary to provide hot water at all times must also be determined. This involves a study of the sequence in use of the various fixtures and probable duration of use at any one time. In a large hotel, shower baths, for instance, may be taken by guests at any hour of the day or night, but this demand is not likely to be concentrated. On the other hand, in schools there is a rush for the showers at the end of each gymnasium period and the hot water storage must take care of this brief but heavy load. Experience has shown that by multiplying the hourly heating capacity previously determined by a factor which depends upon the type of building involved, a satisfactory storage capacity is determined. As an example, referring to Table 1, supposing it is determined that the hot water fixtures of a large hotel indicate the use of hot water at the rate of 5000 gal. per hour. It is known from experience that these fixtures will not all be used all the time so we multiply by the "use" factor of 25%. In other words, if the heater heats at the rate of 1250 gal. per hour, it will, in all probability, have ample heating capacity. The hot water storage capacity would then be 80% of the hourly heating capacity or approximately 1000 gal. This method of determining the amount of heating capacity and storage is, of course, approximate and, in general, conservative. The architect or engineer using this method must also temper his judgment with his own background of experience.

In textile mills, laundries, paper mills and other industries, it is frequently necessary to make a detailed survey before the requirements can be accurately determined. Sometimes it is necessary to install one or more water meters, preferably of the recording type, to determine the demand rate. This, in addition to a study of the sequence and duration of operations demanding hot water, usually provides the designer with enough information to proceed with confidence.

In view of the importance and widespread use of storage heaters, and the fact that one or more such heaters is in operation in practically every large building requiring hot water, the writer has elected to illustrate, in this paper, the changes and advantages of the welding of storage heaters as compared with riveted construction.

Storage Heaters

Storage heaters, as such, apparently made their appearance in the period of 1880 to 1890, and their use increased rapidly as their advantages became obvious. Riveted construction was considered the standard and preferred design until recent years. Early attempts to fabricate these heaters by welding were not too successful, due principally to the lack of any perfected welding technique. Furthermore, it was not realized that changes in design were necessary in some cases before a satisfactory welded job could be accomplished. As the result of inferior welding, welded heaters were quickly earmarked as inferior to riveted heaters, and the sales resistance toward welded heaters, not only on the part of the purchaser but on the part of the salesmen as well, was not overcome until the advent of a carefully planned procedure control, using welders regularly qualified in the prescribed manner.

Several weird designs appeared in the picture during the transition period between riveting and welding before a satisfactory welded heater was produced. An example of this was a combination of riveting and welding, in which the manufacturer first riveted the seams and afterward fillet welded the edges of the

longitudinal and girth seams. Needless to say, in welding the seams, the rivets loosened and leaked so that in order to make the shell tight, it was frequently necessary to deposit a bead of welding around many or all of the rivet heads.

Riveted Design

Figure 2 illustrates a riveted type of storage heater. This heater consists, essentially, of a cylindrical shell enclosed at both ends acting as a water storage reservoir

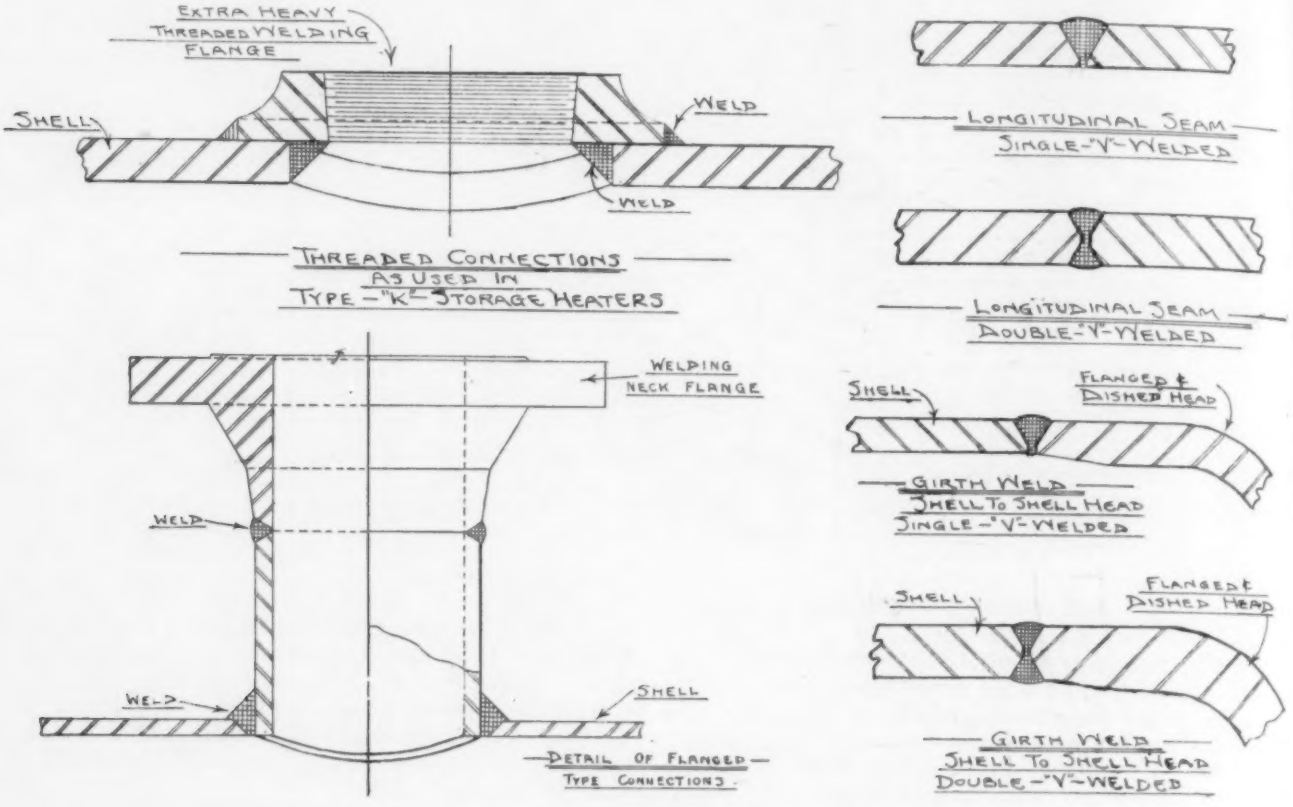

Fig. 4

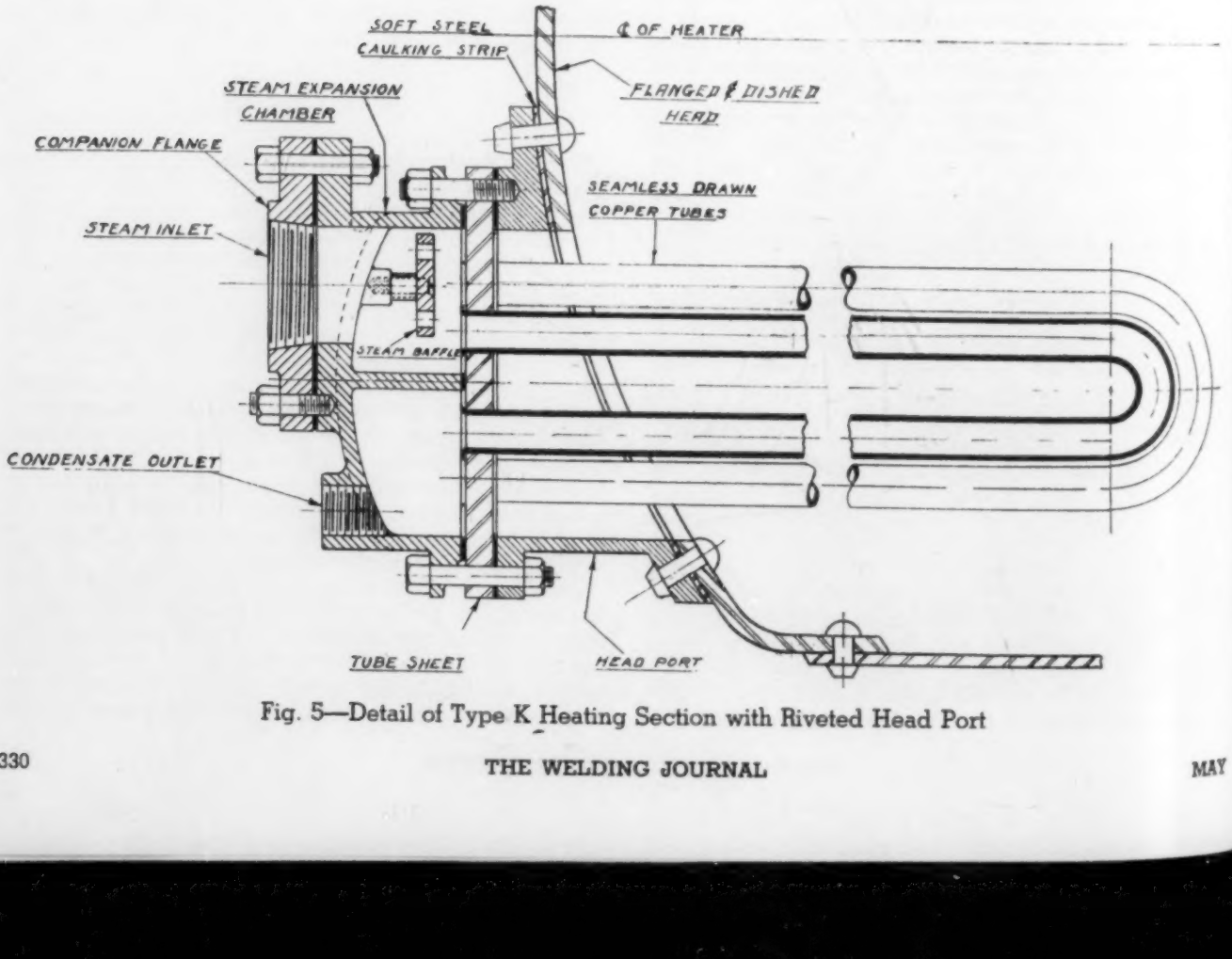

Fig. 5—Detail of Type K Heating Section with Riveted Head Port

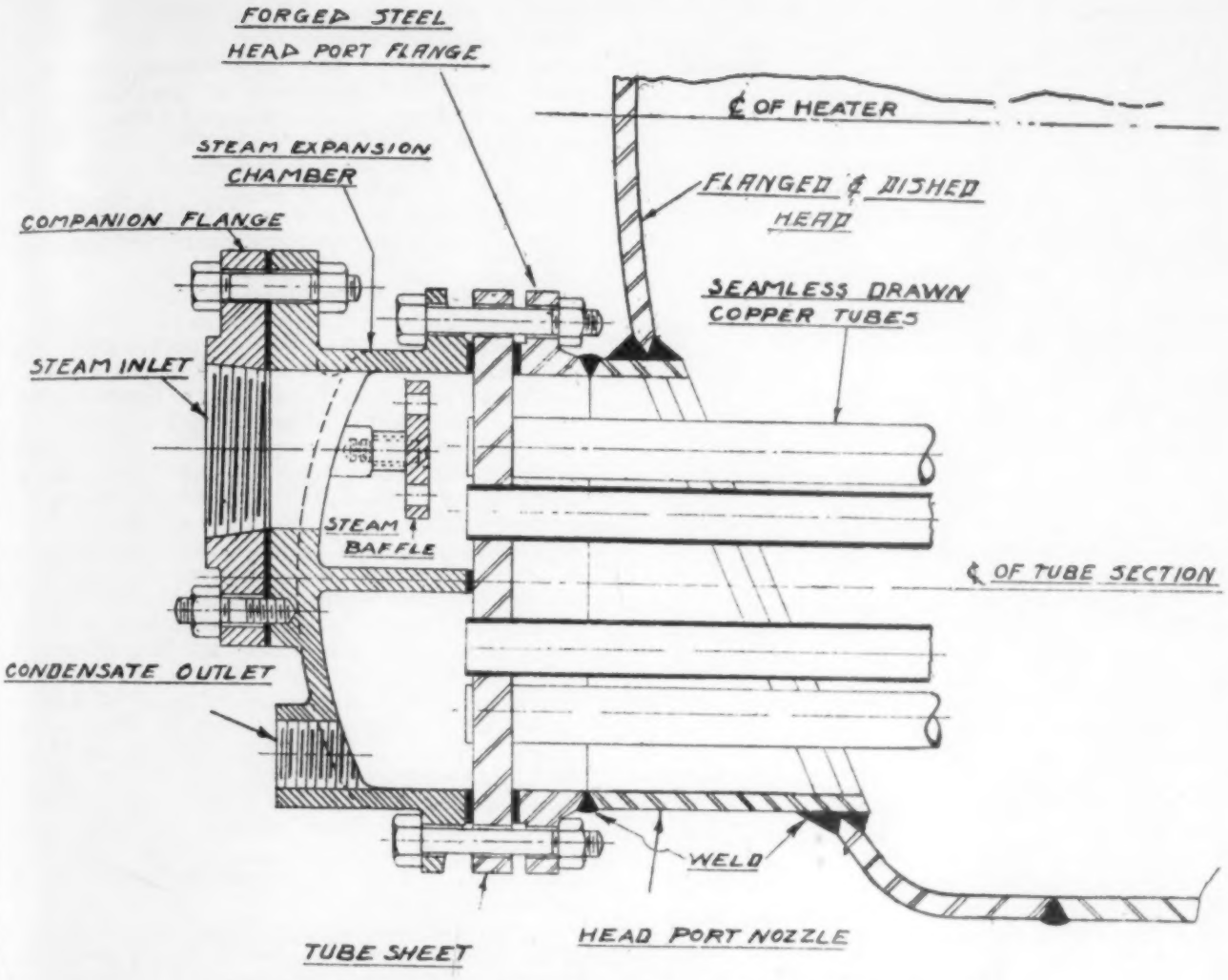

Fig. 6—Detail of Type K Heating Section with Welded Head Port

containing a steam actuated heating element located as low as possible. Steam admitted to the interior of the tubes heats the water contained in the shell. The shell is designed to withstand the normal pressure in the water mains to which it is connected and which is usually in the vicinity of 100 psi. gage. The longitudinal seams are usually of the double riveted lap type in sizes up to 60 in. in diameter. For larger diameters, they may be triple riveted lap, double riveted, double butt, or triple riveted, double butt, depending upon the diameter, working pressure and efficiency of seam required. The girth seams are usually single riveted lap. A manhole, of the integral flanged type, 11 x 15 in., with yoke and cover, is incorporated to provide access to the interior to all but the smaller sizes. Piping connections for water inlet, outlet, drain and miscellaneous connections are castings or forgings riveted in place. The port to which the heating element is attached is a casting riveted to one of the concave heads or to the side of the shell in vertical heaters.

Stocking plates and heads for the immediate production of storage heaters after receipt of orders is simplified by adhering, as far as possible to a set of standard shell diameters and lengths. A list of our standard sizes of storage heater shells is given in Table 2. Special sizes are frequently manufactured to order when limitations of space prevent the installation of a standard size.

It should be noted that the headport to which the tube sheet and steam distributing head are bolted is a casting, for which a pattern is required. Since there are many combinations of heating capacity, storage capacity and design pressure, and since these castings must fit the contour of the flanged and dished heads of horizontal heaters or the shells of vertical heaters, the initial cost and maintenance of pattern equipment is a substantial item.

Welded Design

Storage heaters are unfired pressure vessels and, as such, must be designed and fabricated in accordance with existing safety regulations provided by the laws of the state or municipality in which the installation is to be made. Rules covering the construction of unfired pressure vessels have been worked out in detail by the American Society of Mechanical Engineers and are presented in Sections 8 and 9 of the A.S.M.E. Code for Unfired Pressure Vessels. These rules specify, in detail, the procedure by means of which welders may be qualified for welding unfired pressure vessels and the materials which may be used in their construction. The materials are specifically identified by reference to corresponding A.S.T.M. Specifications where applicable.

When designed and manufactured in accordance with the requirements of the A.S.M.E. Code and so stamped, the pressure vessel is acceptable for insurance purposes.

Table 2—Storage Capacity and Over-all Dimensions of Standard Sizes of Shells for Storage Heaters

Storage Capacity, Gal.	Shell Diameter, In.	Over-all Length, In.	Weight, Lb.
60	18	60	400
75	18	72	450
110	24	60	600
130	24	72	700
150	24	84	800
170	30	60	750
200	30	72	850
240	30	84	950
280	30	96	1,050
340	36	84	1,300
400	36	96	1,450
450	36	108	1,600
500	36	120	1,800
530	42	96	1,850
680	42	120	2,150
800	42	144	2,500
970	42	168	2,900
870	48	120	2,850
1,050	48	144	3,250
1,250	48	168	3,700
1,400	48	192	4,100
1,100	54	120	3,250
1,300	54	144	3,700
1,500	54	168	4,200
1,800	54	192	4,700
1,300	60	120	4,300
1,600	60	144	4,900
1,900	60	168	5,600
2,200	60	192	6,200
2,300	72	144	6,500
2,700	72	168	7,300
3,100	72	192	8,100
3,700	84	168	8,800
4,300	84	192	9,700
4,900	84	216	10,600
5,500	96	192	12,500
6,300	96	216	13,800
7,000	96	240	15,000
7,800	96	264	16,200
9,050	108	240	18,700
10,000	108	264	20,200

Several states and a number of municipalities have adopted the A.S.M.E. Code and pressure vessels coming within the scope of the Code must be designed and manufactured in accordance with the provisions contained therein before acceptance.

Since the details involved in selection of materials to the proper specifications, the preparation and shaping of parts to be welded, and the proper procedure control of welders are all fully outlined in the A.S.M.E. Code and are, therefore, matters of common knowledge, it is unnecessary, for the purpose of this paper, to go into this phase of the subject in greater detail. As a matter of interest, however, a number of typical welding details are included in Fig. 4. It should be added that all welding used in the construction of these storage heaters is shielded arc, using a cellulose coated rod.

Of special interest in the construction of these heaters is the port in which the heating element is installed. Formerly, this was an iron casting riveted in place, as shown in Fig. 5. Before it could be satisfactorily welded, however, the design had to be very substantially changed. The details of the port as redesigned are outlined in Fig. 6. The cylindrical portion consists, in the smaller sizes, of a short length of steel pipe. In larger sizes, it is more economical to roll up a piece of steel plate with a butt-welded longitudinal seam. By making the cylinder of the necessary thickness and allowing it to protrude inside the flanged and dished head, sufficient reinforcement is provided to compensate for the metal removed in cutting out the section of the head to permit passage of the heating element. The bolting flange, to which the tube sheet and steam chamber are bolted, may be fabricated either by Van Stoning the end of the cylinder and providing a suitable backing up flange, or by welding on a steel plate flange or by butt welding on a welding neck type of flange. The welding neck flange is preferred since only a simple butt weld is required to attach it to the cylindrical part of the port, but the cost of the welding neck flange itself is considerably greater than that of a steel plate flange.

Recently, the writer developed a method of producing welding neck flanges to meet our storage heater requirements by fabricating them from bar stock. These rectangular bars, of the proper cross section, are scarfed and butt welded end to end to form a continuous length of 60 to 100 ft., depending upon the size of bars and total weight involved. The bar is then drawn slowly through a gas furnace, where it is heated to about 1500° F. and immediately coiled on a standard pipe bending machine in a spiral coil to approximately the required diameter. While still hot, each complete circle is torch cut and flattened. The ends are scarfed with a torch and butt welded. A few minutes' machining on a vertical turret lathe and the welding neck flange is complete, ready for drilling the bolt circle. Since only a relatively few sizes are involved and the requirements in each size are fairly large, by taking advantage of quantity production, we are able to produce these flanges for substantially less than the cost of forged steel flanges purchased in the open market, with the added advantage that they can be manufactured for stock at our convenience, utilizing our own labor and equipment. They are also used as bolting flanges, for other types of heat exchangers, which increases their use considerably.

We have also recently adopted the practice of welding in the manhole frames instead of having them flanged integrally with the head at the mills. It was previously our standard practice to stock plain flanged and dished heads for one end of each different shell size and a corresponding number of heads with integrally flanged manhole frames, as shown in Fig. 7, for the other end. By welding in the manhole frame, as indicated in Fig. 8, we are able to substantially increase the flexibility of our stock, by stocking plain, flanged and dished heads only. The collar forming the gasket surface for the manhole cover is made amply strong to provide the necessary reinforcement to compensate for the metal removed from the head and fully complies with the requirements of the A.S.M.E. Code.

Other Advantages of Welding

It is a well-known fact that water at a low temperature can hold more oxygen in suspension than water at a higher temperature. Therefore, water saturated with oxygen at its normal ground temperature is forced to release it as its temperature is raised. At 212° F., it is nearly all released. In storage heaters, the usual practice is to heat water from the ground or tap water temperature, which is usually in the range of 40 to 70° F., up to a final temperature of 180° F. The temperature is controlled at 180° F. by means of a temperature regulator which automatically shuts off the steam when the desired water temperature is reached. It is clear, therefore, that in heating water through a temperature range of over 100° F., a considerable percentage of the entrained oxygen is released. This released oxygen immediately tends to react on the interior surfaces

Fig. 7—Detail of 11 In. x 15 In. Manhole

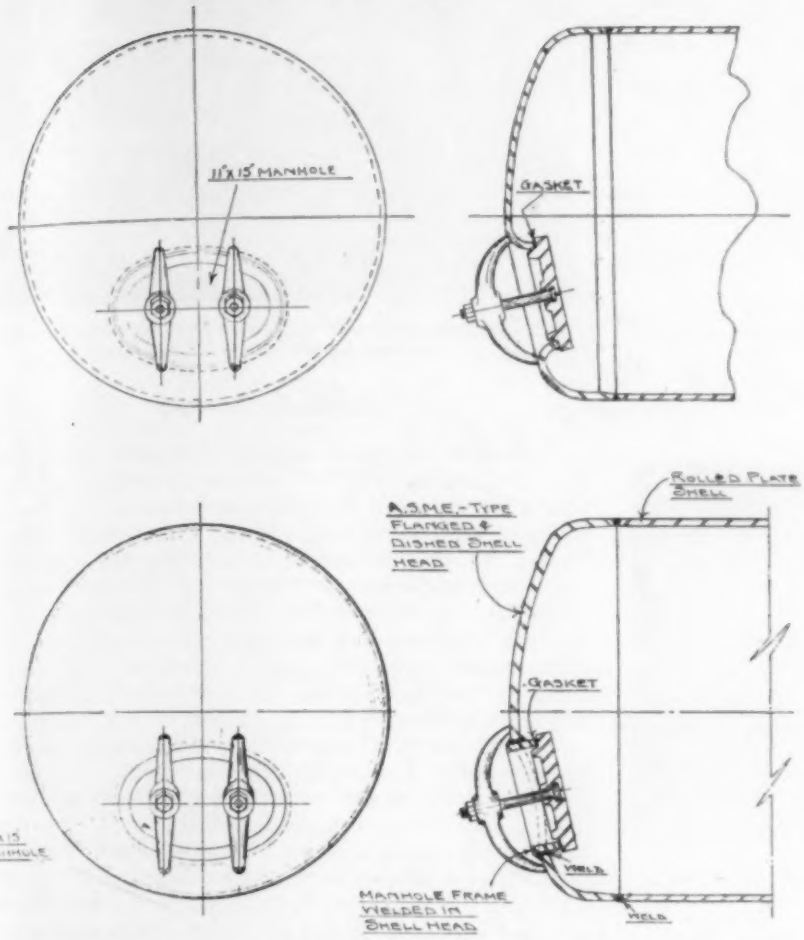

Fig. 8—Detail of 11 In. x 15 In. Manhole Used in Type K Heater Shells A.S.M.E. Code Construction

of a heater with steel shell, producing iron oxide or rust. This condition is undesirable for two reasons. First, because the corrosion, once started, usually continues until a point is reached where the shell must be replaced. Second, rusty water is a very great nuisance and considerable labor is frequently required in cleaning the heaters periodically to keep the water as clean as possible. Some grades of water are more corrosive than others, but in many cases water contains scale-forming elements which are precipitated on the steel surface as the temperature is raised, thus forming a protective coating over the steel and substantially reducing the rate of corrosion.

In answer to a demand for storage heaters in which the rusty water nuisance is eliminated, rust resisting enamels of many different makes have been tried, both experimentally in the laboratory and under actual service conditions. Few of them will stand up for any length of time, and even the most resistant ones usually have to be renewed every few months to give adequate protection. Galvanizing and other corrosion retardants have been used with more or less success.

Since, in many processes requiring hot water, even small quantities of iron cannot be tolerated, the preferred solution in such cases is a design in which the water comes in contact with nothing but non-ferrous metals in passing through the heater. Thus, many storage heaters are built with steel shells lined throughout with copper or other non-corrosive metals. Though it is not impossible to line the interior of a riveted shell, the designer has to contend with rivet heads and butt strap joints. The problem is greatly simplified in a welded shell using butt-welded seams which produce a smooth interior.

Storage heaters are also manufactured from steels clad on one side with non-corrosive metals such as stainless steel or nickel. Welding much simplifies the manufacturing of such materials. Using butt-welded seams, the abutting steel parts of the plates are electric arc welded, using a cellulose coated steel rod, while the abutting clad portions of the bimetal plates are welded with a rod of the same material as the cladding. Thus, the interior of the heater may be entirely stainless steel when fabricated from stainless clad steel plates or entirely nickel when using nickel clad steel plates. The use of bimetal plates rather than solid stainless steel or nickel has the advantage of lower cost.

Storage heater shells constructed entirely of copper silicon alloy plates are also found very satisfactory in combating corrosion. This alloy, consisting of approximately 95% copper and 5% silicon, has a tensile strength closely approaching that of mild steel and corrosion resisting properties similar to those of copper. Riveting shells constructed of this material has not proved too satisfactory since the alloy has a relatively low yield point and there is a tendency for the rivet holes to pull out of shape during the hydrostatic testing of the completed heater. Excellent results, however, are produced by welding.

Comparative Cost Data

In setting up comparative costs of riveted *vs.* welded heaters, the comparison should be made on the bases of storage heaters in which the shells are manufactured from steel rather than from some of the materials previously described, since the number of steel shell storage heaters being manufactured is much greater than those constructed of other materials. A clear picture in regard to what welding has done to reduce the cost of manufacturing is obtained by comparing the complete cost of a riveted heater with the complete cost of a welded heater rather than comparing costs of the component parts.

The cost comparison has been set up for a medium sized heater with a shell diameter of 48 in. and an over-all length, face to face, of flanged and dished heads, of 144 in. The thickness of shell plates is $^3/_8$ in. and thickness of the heads $^1/_2$ in. In each case, the material, both for shell plate and heads, conforms with A.S.M.E. Code Specifications S-1 and A.S.T.M. Specification A-70, latest edition. The cost of the heating element, consisting of tubes and tube sheet assembly, steam distributing head, bolts, nuts and gaskets are the same for either riveted or welded designs. Therefore, these items are omitted from the comparison.

Cost of raw materials and direct labor, riveted	$190.83
Cost of raw materials and direct labor, welded	151.09
Reduction in cost in favor of welded design	$ 39.74
Percentage reduction in cost = 20.8%	
Weight of raw materials used in riveted design	3398 lb.
Weight of raw materials used in welded design	3160
Reduction in weight in favor of welded design	238 lb.
Percentage reduction in weight = 7%	
Cost of direct labor, riveted design	$ 50.40
Cost of direct labor, welded design	36.53
Reduction in direct labor cost	$ 13.87
Percentage reduction in cost = 27½%	

NOTE: The cost of raw materials is based on purchasing those which are subject to quantity discounts in sufficient quantity for the production of 25 heaters. Direct labor cost records are kept continually by the Company, and those included in the above comparative cost analysis were derived from this source.

Fig. 9—Storage Heaters—All Welded Design with Interior Lined Throughout with Copper

The cost of maintenance of factory equipment, power and overhead are practically the same for either riveted or welded construction. The percentage difference in cost of sizes other than the one upon which the cost comparison was made will depend upon several factors, such as the number of shell plate courses, size of port for heating element, etc., but the above may be considered as a fair indication of the average percentage reduction for all sizes as listed in Table 2.

Figures relating to the average number of storage heaters manufactured yearly are not available to the writer. It is estimated, however, that the figure runs into several thousands, of which this Company manufactures a substantial percentage.

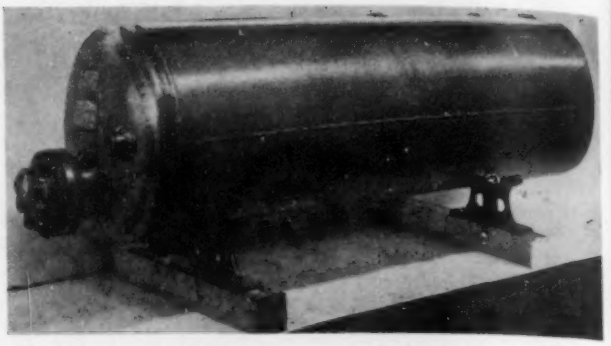

Fig. 10—Storage Heater with Entire Shell Constructed of Everdur—a Copper Silicon Bronze Alloy

Social Advantages

Hand riveting and caulking operations are extremely noisy. One has only to spend a few minutes near an operator caulking a riveted seam inside a closed building to be convinced of this. If the only social advantage gained by the change from riveting to welding was the elimination in the factory of the noise nuisance from this source, the change was worth while. But if riveting produces a noise nuisance in a factory where other noisy operations are in progress, the nuisance is many times amplified in a relatively quiet hotel, school or hospital when repairs become necessary.

Welded heaters have not been in service nearly as long as many of the original riveted heaters so that it is perhaps unfair to say that welded heaters will outlast riveted ones of the same grade and thickness of materials. However, it seems a reasonable assumption that as the shell plates of riveted heaters thin down by the corrosive action of the water being heated therein, the difficulty of keeping riveted seams and rivet heads tight will increase with the age of the heater until it is replaced, as it inevitably will be, by one of welded construction. It should also be added that heaters properly designed for the conditions under which they are to operate, and welded by experienced and properly qualified welders, are practically trouble free in service and require no noisy and expensive repairs.

Finally, the saving of approximately 7% by weight of materials which are of strategic importance to the United States, and the saving in labor of approximately 27½ %, is worth while at any time, but under the present National Emergency, when every effort is being strained to produce more goods in a shorter period of time, the saving in time and materials by welding is particularly desirable.

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(*Continued from page 318*)

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(*Continued on page 346*)

Arc Welding in the Manufacture of Aircraft Propeller Blades*

By Dr. Elek K. Benedek†

Introduction

ONE of the most outstanding engineering problems of the aircraft industry today is the design of propeller blades for aircraft. The efficient transmission of huge horsepower, such as 2000 hp. per propeller, sets up new theoretical as well as practical requirements for the design. This is the reason that propellers made out of lighter than steel metals, such as aluminum or magnesium alloys, will pass away as quickly as the wooden propellers did under the increasing demand of commercial expectations. Duraluminum and magnesium alloys, while they are very light, do not have the elastic stamina required for endurance. That the present solid aluminum alloy (lynite) propellers cannot fill the further requirements needed by larger crafts is well recognized, and is published by outstanding propeller specialists.‡ Whereas, by giving the proper shape to the cross section of the steel blade it can be kept light, yet its elastic energy remains several times greater than that of the above lighter metals.

To alleviate the shortcomings of the conventional propellers, designers attempted to make the blades out of hollow steel, by the process of various kind of weldings. Small and large blades were made of sheet metal by the process of welding, and were found very good in performance and endurance characteristics. These results were due primarily to the outstanding mechanical properties of the steel as structural material, and to the reliable technique of the welding processes used. The best material, such as high-grade alloy steel, when subjected to the best method of fabrication, gave the best results under the complexity of heavy-duty performance requirements.

Past practice and design of welded steel blades, however, did not solve all the problems of the rapidly growing aviation industry, and particularly, not those which did not even exist until just a very short time ago. This is the reason why the writer turned to this most vital problem of propeller blade design, and on the basis of past experience he believes that the complete solution of the propeller design lies in the direction of welded-steel blades and propellers. Light metals, such as duraluminum and magnesium, are deferred already for the same reason as the wood, namely, for the lack of elastic stamina. Efficient design requires such production methods in which the best aerodynamic efficiency is not only incorporated, but in which it will be always duplicated. Due to the possibility of uncontrollable mechanical and aerodynamical imperfection in conventional large blades, there are already so many vibrations in present hollow steel propellers, that even a classification of them is almost impossible.

It is the object of this paper to provide a more effective and simplified welded structure which will not only be better and stronger, but which will be more accessible for production and control, and the elimination of the above defects and vibrations. It also will be shown that welding is the best method today which can produce this improved steel structure, and that arc welding is cheaper and commercially more available than hydrogen or other more specific and delicate welding methods.

Welded Constructions

Welded Steel Propeller with Hollow Shank and Knife-edge Blade

Propeller blades are one of the most difficult machine elements to make, of the aircraft industry today. This is due to the rigid expectation of the propeller mechanism, which is in itself a complete hydraulic motor which has to transmit the engine horsepower into the flight power, at the best possible efficiency. Transatlantic flight diagnoses show that the commercial possibility of such flights often depend on the increase of one single

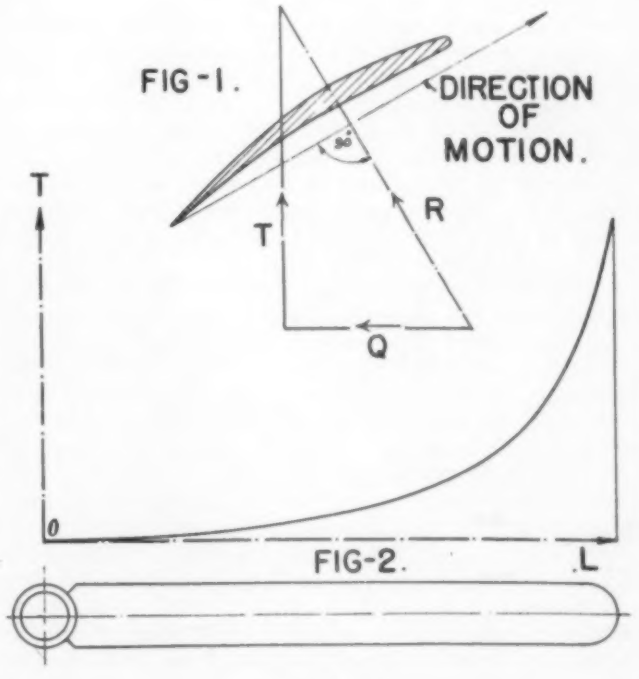


FIG-2.

FIG.-3.

* Second prize paper in the Aircraft Engine Accessories division of the 1940–42 Industrial Progress Award Program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. The award papers showed a possible saving of $1,825,000,000, including 7,000,000 tons of steel and 153,000,000 man-hours of labor available by application of arc welding.

† Consulting Engineer, General Hydraulic Company, Cleveland, Ohio.

‡ See Reiber, H. P., "Quality Control of Hollow Steel Blades," *Aviation* March (1942).

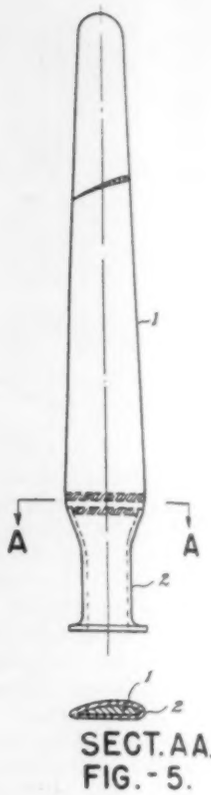
per cent in propeller efficiency. Disregarding aerodynamical requirements, but remaining at the task of transmitting huge horsepower, such as 750 hp. by one single blade, obviously requires the best the aircraft engineering can offer in all possible directions. Considering, also, that the inevitable method of blade mounting at the end of a cantilever crankshaft is given, it is evident that a multiplicity of rigid requirements and problems present themselves for solution right at the start, with the mounting. Critical phenomena such as the flutter of the propeller is only a resonance between engine and propeller vibrations, but the forced vibration of the crankshaft is normal and it is carried over to the forced vibration of the propeller blades. The thrust of each blade will impose a bending moment which is normal to the axis of the blade. The centrifugal force is the most critical. It acts axially on the normal section of the blade. For the purpose of simplicity the consideration of other imposed stresses and phenomena are omitted in this discussion now, but it is pointed out that the basic improvement of the present design has reduced or fully eliminated limitations and dangers in conventional propellers.

It is well known that the major portion of the length of a lynite propeller is so heavy that only a short portion toward the tip remains flexible. It is this flexible end, however, which breaks off and causes the principle danger of conventional lynite propellers. The poor mechanical properties of the aluminum alloy is only partly responsible for the above limitations, i.e., for the excessive weight of the blade, as well as for the breaking off of the tip. Other limitations are due to design factors. These limited factors bar the lynite blades, however, from further application as longer blades on larger aircraft; and there is no way of alleviating these factors in the conventional design.

Figures 4 and 5 show a two-part welded-steel propeller which eliminates the above basic defects of solid aluminum-alloy propellers. The proper blade *1* is made of thin forged steel and at its bottom is arc welded to a hollow-steel shank portion *2*. This hollow-steel portion is practically rigid, while the flexible or knife-edge portion is elastic. It is a knife-edge made of spring steel. The substance of this welded combination is that the forced vibration of the entire blade will have a knodal point at the point of the welded connection, and thus the blade *1* will have its own free and smooth harmonic oscillation along its entire length. This vibration will be substantially different from the rigid forced vibration of the shank portion *2*. The vibration of the entire blade will relieve the tip as well as any other portion of the spring blade from concentrated vibrations and tip breakage. Part *2* is preferably made out of rigid seamless steel tubing of suitable material. It is formed to the proper shape to receive the end of blade *1*, and mounted safely against the maximum load. The welded mounting can be achieved by conventional arc welding, preferably at two zones, such as shown in Figs. 4 and 5. The inside and outside welds are both well accessible for final finish since the shank is hollow and will be polished to the proper smoothness. The necessary heat treatment of the welds and the tempering of the spring blade *1* will complete the process. It can be stated already that there is no chance of the breaking off of the blades at the walled-in and welded end. The good properties of the spring steel and tubing provide all necessary resistance to this welded joint.

Simultaneously, the refined aerodynamical profile throughout the entire length will improve the hydraulic efficiency together with the traction of the propeller as shown in Fig. 2. This figure shows that the traction force is rapidly increasing toward the tip of the propeller

FIG.- 4.



SECT. AA.
FIG.- 5.

(see also Fig. 3). Thus it is obvious that the curve of the knife-edge blade will have a quicker pick up toward the tip than the curve of the clumsy solid aluminum alloy propeller. This propeller supersedes also, in weight, the solid aluminum-alloy propeller, which is an important design consideration. Due to the outstanding properties of the different steel portion, the shape can be made such that the blade stability as well as its radial strength will meet any necessary requirement at a minimum expense of weight. This better streamlined profile will adapt the blade, also, for higher engine speeds without the necessity of using reduction of gearing.

It is admitted that the welding process occupies only a very small space in the entire manufacture of this blade, but that much greater is its importance; and it has no substitute. The danger of mistreatment of the parts by the method of conventional arc welding is very small, since all necessary details may be obtained readily from welding specialists. Arc welding achieves the simplest, cheapest, and strongest connection between the two parts *1* and *2*. The fact that the two parts *1* and *2* may be manufactured separately and finished independently from each other, prior to the welding, is important from the savings and production point of view. It reduces the cost of necessary machine tools, operations, jigs and fixtures, as compared with the cost of manufacture of the one-piece blade. The entire blade, with the welded joint, can be polished internally and externally after the welding. The danger of tip break-off is entirely eliminated and the low-pitch vibration of the blade quiets the entire performance of the power plant and the plane, respectively.

The above method of fabrication is also applicable with proper changes and modification to non-ferrous alloy propellers. While the conventional blade carries a long and heavy inefficient shank, with a short fluttering, inefficient tip, the present design embodies a light, hollow short shank, and carries an elastic, long blade, which is efficient throughout its entire length. It will be seen, also, that the arc welding, with selected simpli-

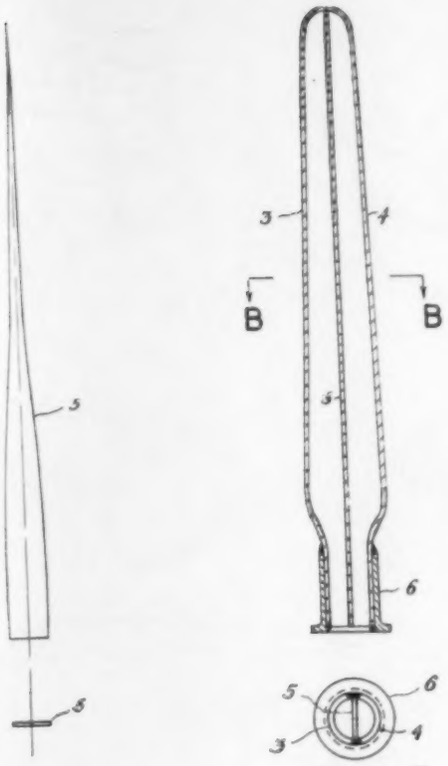


FIG. 6.

FIG. - 7.

fied material and design, eliminates all scrap from the manufacture of the propeller blade, and thus it greatly reduces its cost through the saving in labor and material.

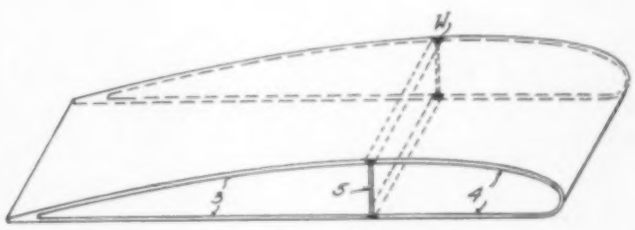
Welded Steel Propeller Blade of the Rigid Skin and Reinforced Structural Steel Type

Some of the present-day conventional hollow-steel propellers have reached considerable success, such as the Smith welded hollow propeller of the Aviation Corp., for small blades, and the hollow blades of the Aero-Products Corp. of General Motors Corp., for large blades. However, close consideration shows that the large blades, particularly, need considerably further improvements, since the material becomes crystallized under the combined strain of the heavy duty and associated vibrations, and the wall of the blade opens up or bursts.

One of the reasons for the limitations of the entirely hollow, conventional steel propellers, lies in the weakness of their design as it will be clear from Fig. 1. This figure shows that the resultant aerodynamical force *R*, of each propeller element acts in a direction substantially normal to the chord of the profile. Since the design of the conventional hollow-steel propellers provides no direct strength or reinforcement in the normal direction, the material of the hollow section becomes crystallized under the vibration stresses, and the section will burst. The present design shown in Figs. 6 and 7 does not only eliminate the above structural weakness of conventional hollow propeller blades, but at the same time it greatly increases its structural strength and durability. Through the introduction of the reinforcing member, *5*, into this new combination of the blade structure the resistance against buckling or bending will be increased as the third power of the respective height of member *5*, in each transverse section of the blade. This reinforcing member, *5*, passes throughout the entire length of the section, and places in the direction of the resultant aerodynamic load *R* the necessary reinforcement. With its height and major moment of inertia in this direction, it will withstand and resist all loads and vibrations in this direction. At the same time it brings into reinforced coaction the suction and the pressure side of the profile of the blade. This reinforcing coaction greatly increases the transverse strength and stability of the blade, and it qualifies the structure for more severe applications than known heretofore. A substantial weight reduction is also obtained for the same reason.

The reinforcing member *5* thus does not only add its own structural strength to the strength of the profiles, but it eliminates transverse vibrations of the suction and pressure profiles with respect to each other under the resultant load, *R*. This latter vibration is often called the breathing of the propeller. Its negative effect is the early crystallization of the material and the reduction of hydraulic efficiency of the blade. Evidently a vibratory profile has a worse circulation than a stabile, positive profile. Further, the reinforcing section produces a gain in hydraulic efficiency by way of better profile. When no reinforcing is provided in the hollow profile a heavier wall section automatically becomes necessary. But reinforced with a longitudinal beam, as at *5*, gives the design a better streamlined profile. From the above consideration it is obvious that this structure has a greater resistance to both torsional and centrifugal force vibration stresses, and will stand greater rotary speed.

A more than two-compartment profile design is shown in Fig. 9. Here are provided three beams, *7*, *8* and *12*, respectively, which divide the profile into four compartments. This design is provided for larger propellers where further reduction in weight and gain in strength and rotary speed are imperative. As for the welding technique of such propellers, it will be seen that, for instance, the central beam *7* is welded first to the top and then to the bottom of plates *10-10*, respectively, whereupon, the front and rear beams *8* and *12*, respectively, will be welded to the edges of the top and bottom plates *10-10*, respectively. Thus it is forming so far two closed compartments. The leading and *2* and trailing end *11* of the section thus will be welded along the edges of the top and bottom plates *10-10*, respectively, of the central compartments and beams *8* and *12*, respectively. It will be noted that this structure, while it provides



SECTION - BB.
FIG. - 8.

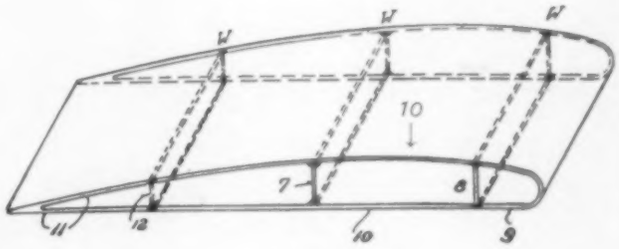


FIG. - 9.

simple means to comply with the rigid requirements of good efficiency and perfect geometry of the profile, gives also greater rigidity and strength at reduced weight per horsepower ratio. In the foregoing designs the profile plates *9*, *10* and *11* are contributing substantially to the strength of the blade, since they are heavy and in welded rigid coaction with the axially extending longitudinal beams *7*, *8* and *12*, thus forming part of the whole strength structure. In the following modifications the strength structure will be separated from the skin plates or airfoil structure.

Welded Steel Blade of the Elastic Skin and Complete Structural Steel Body Type

Figures 10 to 13 show a novel blade structure for improved streamlined and light-weight propellers of the larger sizes. The combination comprises axially extending beams *13* to *20*, properly spaced and positioned in such a manner that they give lateral strength and resistance against thrust, centrifugal and torsional forces, and at the same time provide the proper form for an airfoil section as in Figs. 11 and 12. At the shank as in Fig. 12, the beams will be disposed in a similar way, inside a longitudinal straight cylinder. Further sections, as in Fig. 10, the profile plates *21* to *27*, will be carefully formed and positioned to determine and fix the final relative position of the axial beams *13* to *20*. The profile plates may be made by stamping as in Fig. 13, and sawed to subsections to fit between the longitudinal beams *13* to *20*, as in Fig. 10. Appropriate welding fixture will enable the welding as at *W*. It will be noted that the beams *13* to *20*, are the main longitudinal stress members and they remain integral longitudinally, as in Figs. 11 to 12. The great advantage of the use of the stamped airfoil profiles, as in Fig. 13, is that they can be present in their theoretical position by means of simple welding fixtures, and then be sawed into individual pieces prior to the final welding assembly, as in Fig. 10.

Each adjacent beam and profile plate, respectively, thus forms a plurality of cells which are yet open from the top and from the bottom, but will be closed by the skin. The skin may be wrapped around the strength structure, or pulled over on it, in stressed position from the shank end toward the blade. A two-part skin may be welded to the top and bottom of the strength structure along the longitudinal beams *19* and *20*, respectively. The shank portion of the blades may be formed and finished as in Fig. 7, embodying the geometry of Fig. 12. This design lends itself to very accurate profile control and easy checking up of the pitch of the blade, particularly in aerodynamical respects. The skin may

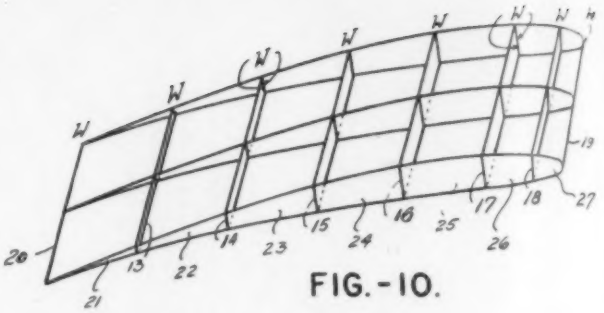


FIG.-10.

FIG.-12. FIG.-11.

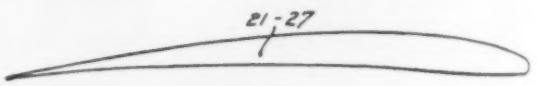


FIG.-13.

be made renewable, as primarily it is only a coverage, resting tightly against the beams and profile plates, and withstanding the vacuum and dynamic pressure of the airflow. Since both the suction and the pressure are less than one atmosphere, it is obvious that very thin sheet metal skin will perform this pressure duty. Breathing of the profile is thus eliminated, and considerable weight reduction is obtained. The repair of the blade, due to skin disease, becomes easy and effective by either exchanging or patching up the damage. The new elements *21* to *27* increase torsional rigidity and transverse stiffness of the blade, since they reinforce the beams *13* to *20*, as did beam *5*, on the profile plates *3* and *4*, in Fig. 7.

The facts that standard material of good alloy steel and standard welding process, such as arc welding, may be used in the production of propellers increase productive capacity and possibilities of the aircraft industry, and provide the large aircraft with efficient and safe propellers. Due to the simplified structure in this latter case, expensive dies are eliminated, heat-treating processes greatly reduced or eliminated, greater finished values are produced and further design changes at less expense are made possible.

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Resistance Welding Below the Frost Line

By A. L. Munson*

REFRIGERATION has become a very essential tool in the fabrication of implements and materials of war. Innumerable new uses have been found for refrigeration during the last few years, particularly in industry.

Welding has become streamlined for war. By utilizing its speed and other advantages, our country has been and is able to pour forth amazing quantities of war materials, which in a great many cases would have otherwise been impossible.

When we think of welding, we think of heat—glowing red or dazzling white—which causes metals to fuse together in a strong bond. There are any number of welding processes: gas welding, arc welding, forge welding, flash welding, butt welding and resistance welding, to name a few.

The spectacle of two pieces of metal bristling with white frost coming together on two strips of aluminum, and making a weld, is spectacular and appeals to the magination because it is so contrary to preconceived notions of natural phenomena. The two are so diametrically opposed—heat and cold. But that is exactly what we do. And it is just this combination that has made aluminum spot welding entirely practical, and so much faster than riveting.

Spot welding is a metal-fabricating process in which the fusing temperature is generated at the joint by the inherent resistance of the joint to the flow of an electric current. It is the attaching of one part to another so as to maintain this attachment against the application of design loads to other parts.

In any resistance welding operation, the basic formula is expressed as "Heat equals I^2RT," in which I is the secondary (or welding) current in amperes, R is the electrical resistance of the parts being welded and T is the time.

Three of the fundamental factors affecting this formula are: Current, time and pressure—and one resistance-welding machine must have means for controlling these factors very accurately.

Current requirements for welding aluminum are three or more times the values used in welding steel of similar gage. A spot welder designed to weld two pieces $^1/_{16}$-in. thick steel will not be heavy enough to weld the same thickness in aluminum.

Pressure required to bring the upper and lower electrodes together over the joint with sufficient force to do the welding can be applied by air or pneumatic cylinders. The amount of pressure must be adjusted since different types and sizes of materials require widely varying pressure between the electrodes and the work.

Accurate timing control is very essential in any resistance-welding machine. In the early days manual pressure and human timing were depended upon, but with the rapid growth and use of this welding process, most accurate and dependable means have had to be used to obtain proper timing and correct pressures. The contactor type of control was widely used at first but it is now giving way very rapidly to the more accurate electronic controls, which provide timing in "cycles" instead of seconds. Since there are 60 cycles in each second in a normal power supply, this means timing is possible to $^1/_{60}$th of a second.

In order to make a weld a welding machine must be carefully arranged to perform certain definite functions in a certain sequence—as determined by the settings in the control panel. Current cannot be permitted to pass through the electrodes until they have been brought together on the work under the proper pressure. Therefore the machine sequence would normally be:

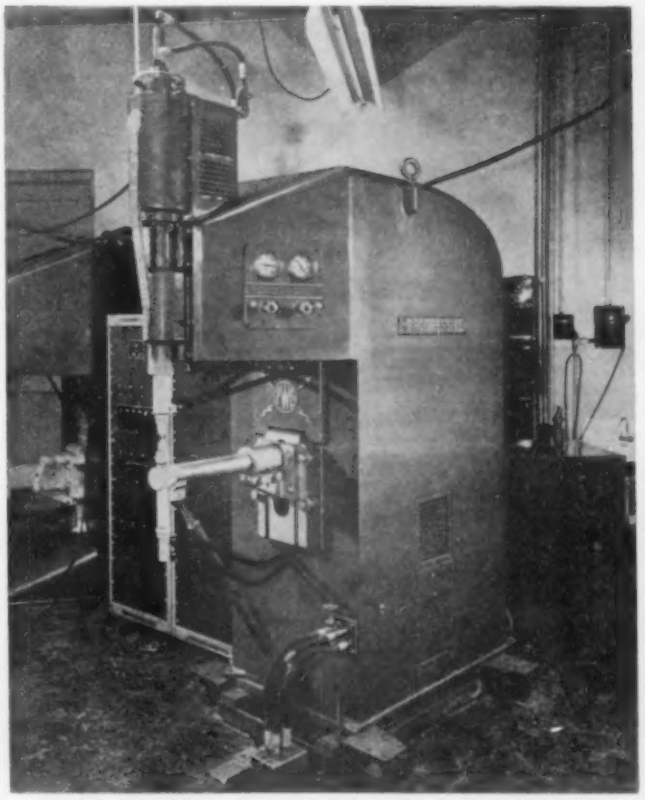

Fig. 1—Mechanically Cooled Aluminum Welder

Resistance welder for aluminum. The flexible connections to the holders carry the mechanically refrigerated cooling agent, in this case cooling the holder as well as the electrode itself. Later models employ a special adapter which permits cooling of the electrode only.

* Frostrode Div., Weltronic Corp., Detroit, Mich. Article prepared from notes for a talk given by Mr. Munson before the Detroit section of the American Society of Refrigerating Engineers.

1. Squeeze Time.—The process of bringing points together and holding them together under pressures for a definite time.

2. Weld Time.—Often broken up into a series of pulsations of heat time, cool time, etc., as for steel to prevent overheating and melting of the material. The duration time in which the welding current is applied. In aluminum welding this time is a fraction of one cycle since a very high current is used and must be of very short duration, due to the nature of the material.

3. Hold Time.—The time for which the points must remain closed after current flow has stopped to give the metal a chance to fuse and cool. This is sometimes called "Forging Pressure."

4. Off Time.—When automatic operation is desired there must be an off time to allow moving the work to a new spot location in readiness for another weld.

With synchronous timing controls, which are becoming very popular, each timing cycle is begun at that point on the sine curve where it is zero in current value. This eliminates sudden line surges which are very objectionable and which cause fuses to blow and the power companies to object.

Before a weld can be made, the work must be cleaned and otherwise prepared. The purpose of surface preparation is to eliminate wide variations in the heat of welding caused by variations in the contact surface resistance due to foreign matter on the surface—and also to reduce the heating between work and electrodes.

Work can often be ruined by improper treatment or cleaning, and in aluminum work, premature "pick-up" of aluminum by the electrode face will result if the surface is contaminated. Since aluminum has the unhappy faculty of picking up soon enough even with proper cleaning, this cleaning is very important and is given a great deal of serious attention by all good welding engineers.

The surface resistance of aluminum sheets is increased by the pressure on the sheet of foreign substances

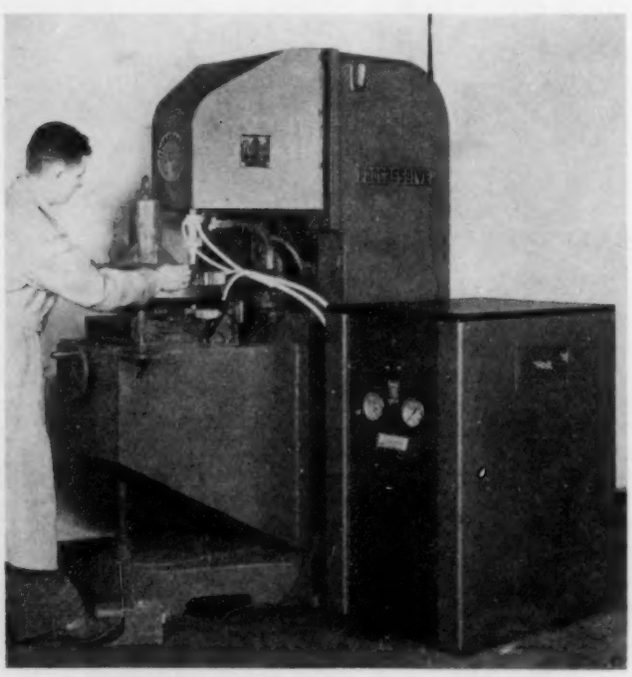

Fig. 2—Welding Machine That Does an Upsetting Job

In the application shown in this illustration the welding outfit has been adapted to perform an upsetting job. In this job 1/4-in. iron rods are heated until they become soft, and then pressed into the countersunk holes. By cooling the electrodes on this equipment, their life is increased five or six times over what it was previously.

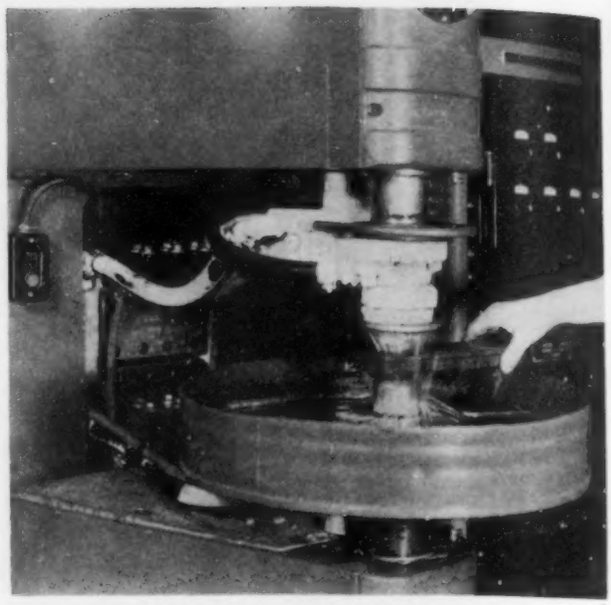

Fig. 3—Cooling Has Two Functions in Armor Plate Welding

Armor plate welder. Water spray is part of tempering chill which helps the refrigeration system in providing the quick chill necessary to accomplish the tempering. A thermocouple buried in the lower electrode controls the amount of heat put into the weld very accurately, and also controls the chilling cycle.

deposited either by handling or by some chemical action of atmosphere, etc. Fumes, smoke, moisture, etc., in the atmosphere will have definite effects on the oxide coating. Dirt, grit and dust will also cause some trouble and can often limit the number of spots obtainable between electrode dressings. Considerable investigation has been carried on along these lines.

Aluminum alloys readily alloy with copper, *especially* at high temperatures. It is therefore very important that the temperature of the copper electrode face, which is in contact with the aluminum, be kept as low as possible, to avoid "pick-up" of the aluminum being welded.

This is the basic reason for the use of refrigeration. We try to hold this *face temperature* down below the fusion or alloying point in order to retard alloying, or "pick-up." If we could consistently do that we might be able to weld forever on one set of electrodes.

Refrigeration also assists materially in retarding the so-called "mushrooming" of electrodes. Heat and pressure and the constant pounding together cause distortion in the shape of the electrode, at the face. This, too, is a serious cause of short electrode face life.

There are two commonly used cleaning methods—chemical cleaning, and mechanical cleaning. Each method has its boosters and very often the nature (or shape) of the job will determine which method to use.

Chemical cleaning seems to be best, and to be most popular. Extreme uniformity can be obtained and this is important because without uniformity, it is impossible to produce equally consistent welds. Little skill is required by workers in this type of cleaning since they need only to load and unload the tanks on a definite schedule. The length of time for which the material is dipped in the bath must be controlled to obtain the high uniformity desired. More spots can usually be obtained between point dressings with this process. However, a rather elaborate initial installation, usually including tanks, hoists and baskets, is required. This is quite expensive, and workers must use care to avoid damage or injury from acids, and to time the cleaning process itself accurately.

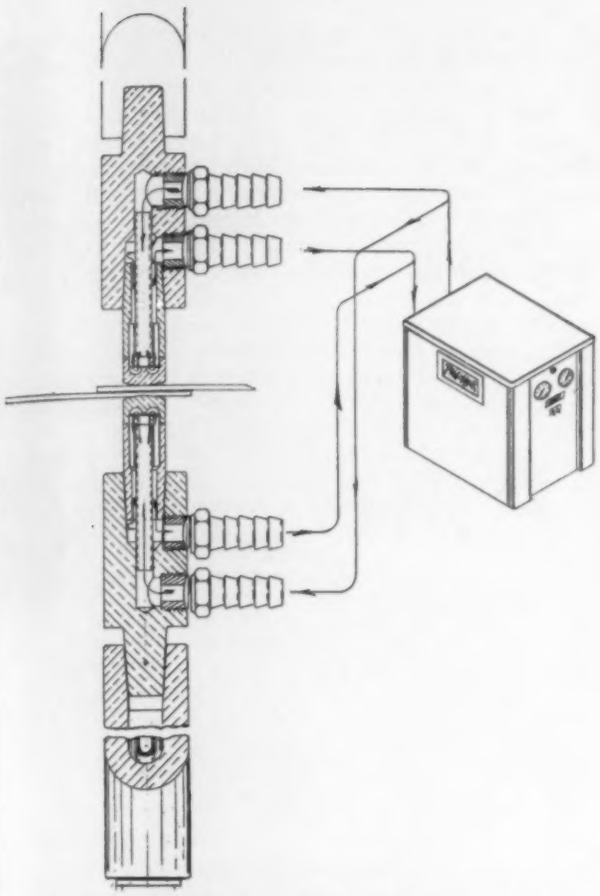

Fig. 4—How Cooling Is Carried to Electrode Tip

This drawing shows the course of the cooling agent flow from he Frostrode through the adapters to the electrodes and return. Both the Frostcap and the insert provide finned surface to provide more rapid heat transfer.

Mechanical cleaning usually requires skilled operators because great care must be exercised in removing oxide coating so as not to thin or roughen the alclad surface of the sheet. However, offsetting this disadvantage, this method allows cleaning of any part of a surface without the necessity of treating the entire surface. Initial equipment required is small and inexpensive. While cleaning will not be so uniform, careful operators can obtain satisfactory results.

Whichever method is used, care should be taken to weld the metal as soon after cleaning as possible—preferably within an hour or two to prevent recontamination of the cleaned surface.

Now, with the welding machine properly set for the work to be done, and the work properly cleaned, welding operations can begin. Many samples are made first, to check the control settings. Shear strengths must meet rigid specifications. Too much current will cause "spitting" or burning, with the danger of serious accidents when molten metal splatters from the weld. Not enough pressure will also cause "spitting." Too much pressure causes objectionable indentations in the sheet. Too little heat means weak welds. An accurate middle mark must be reached before production welding can begin.

This brief summary of welding practice will indicate what we are up against when we try to apply refrigeration to a welding machine. It is essential to know welding before attempting to apply refrigeration to this complicated welding procedure. I cannot stress that too much.

There is no easy way to determine refrigerating loads. Each size, or thickness, of sheet requires different heat. The condition of the sheet will cause variations. The type of oxide coating will cause wide variations. Each alloy or alclad will be different.

The condition and type of electrodes will cause very wide variations. The throat depth and height must be considered. Any ferrous metal in the throat field will make a difference. Method of cleaning and consistency of cleaning are important. Atmospheric conditions are important. Polarity of electrodes is important. Dr. Hess of Renssalaer Polytechnic Institute has obtained some interesting data on this.

Cooling surface available in the electrode is of utmost importance. Only recently has any attention been paid to this important factor. The Frostrode people have developed a new electrode called the Frostpoint which they are now furnishing with their units. Greatly increasing cooling surface and a replaceable finned cap are incorporated in its design as well as a fool-proof "deflector" or coolant tube. Coolant flow and volume of coolant are also very important.

All these factors and more must be carefully considered when refrigeration is to be applied to welding. It is essential to know welding before even the loads involved can be properly determined. Each type of welding machine is different in operating characteristics, too. The variables encountered are staggering and only an individual with welding knowledge and experience in this type of application can hope to solve them successfully.

The many plant welding engineers are the real unsung heroes of this welding business. They get little credit but they certainly turn out the equipment, and have done a remarkable job. Their untiring efforts to improve welding practice and technique have led to the increasingly wide acceptance of spot welding.

Many structural parts are being spot welded today. This would have brought horror-stricken protests not so very long ago, for until recently few designers or fabricators would believe that any weld could match the strength of a rivet. It is gratifying to know that our own efforts have assisted in this transition. When properly designed and applied, refrigeration can work miracles in speeding aluminum fabrication in spot welding. And since spot welding is so much easier and speedier than riveting—it's like using a sewing machine on sheets of aluminum—this country of ours is really turning planes out faster and faster every week. Most of the aircraft plants now must almost be measured in latitude and longitude.

Refrigeration Must Be Properly Applied

But, many people still ask, is refrigeration really worth while? There has, unfortunately, been some conflicting evidence in the welding industry on this. There have been papers pro and con which have tended to confuse. Some plants say it isn't worth the extra cost—that the improvement is not great enough. However it has been our experience that when properly applied, refrigeration has almost invariably shown considerable and worthwhile improvements—often 500% improvement and sometimes much more.

Perhaps the greatest cause of the variations in results obtained is due to the human element plus the varying machine characteristics and different cleaning conditions, etc. All the variables mentioned above enter into this, too, and in greater or lesser degree determine the results to be obtained. Preconceived notions, prejudices and

occasional lack of cooperation of the operators and/or welding engineers can be quite a hurdle.

Different manufacture of welding machines causes a wide variation in welding heat, and consequently in results obtained. Time interval between cleaning and welding can make a big difference. The type of electrode used will make the biggest difference of all.

By using the new frostpoint electrode with the Frostrode unit we have been able to make as many as 2000 spot welds on 0.064-in. 24ST Alclad between cleanings. The shear tests were unusually consistent and they were entirely acceptable.

Field production tests have shown 600 and 900 spots on the same material between cleanings, on the stored energy type welder, which is more difficult to cool. Previously 30 spots or 50 spots was considered a good average. This is a very real improvement as you can see.

Best Coolant Temperature

The best coolant temperature we have found to be between 0° and 10° F. A minimum of 2 gallons per minute must be circulated in each electrode. However, there is some evidence indicating that for light gages of aluminum (0.020 in.) a temperature of 15° or 20° F. works very well. But we have standardized on 0° F. since in by far the greatest number of cases it has given much better results.

For steel work, we often use 40° F., such as in gun-type welders. But even for steel we have found 0° F. very desirable in many cases. With a special welder, for example, which permits very accurate heat treating after welding through use of a thermocouple inside one of the electrodes, armor plate can be very successfully welded and heat treated after welding at this 0° F. temperature.

In this operation, a series of pulsating electrical currents of varying intensity are used so that any predetermined degree of heat can be obtained very accurately. Consequently, it is quite simple to obtain approximately the same hardness and toughness in the weld as was in the original metal. Refrigerated electrodes assist in the quick quenching and also greatly retard point mushrooming.

Types of Systems

For cooling the electrode, direct expansion systems have been tried. We experimented with the idea right at the start. However, the moisture bug-a-boo immediately came up as the first and worst obstacle. At the present time it looks extremely doubtful whether direct expansion can ever be successfully applied and made fool-proof. The electrodes themselves must be removed too often to change shape or renew. In using direct-expansion coolants, this would mean actually opening a refrigerant circuit, and to offset moisture pick-up you would have to have a dryer as big as a house.

At present, we use electrodes cooled with a mixture of antifreeze, such as alcohol and water, fed to the tip through rubber hose and a $^3/_4$-in. iron pipe. When we entered the field, we found that tip thicknesses ranging up to $^3/_4$ in. of metal between the coolant and face of the tip were in common usage. Naturally, this provided an overwhelming wall for the refrigeration to work against. Changes in electrodes since then have reduced that wall thickness to the thinnest dimension which will maintain the weight of the electrode under pressures encountered on the job. Experience seems to show that hard copper electrodes are best for jobs where refrigeration is employed.

Electrode tips are commonly dressed with a file and/or oxalite paper of fine texture abrasive. This cleaning is one of the worst headaches since it occupies so much valuable production time. It usually takes from 5 to as much as 20 min. to clean one set of points.

Refrigeration increases the current-carrying capacity of the electrode at low temperatures. Among others, Dr. Henzel has published a very good paper on this which appeared in *Air Conditioning & Refrigeration News*.

Refrigeration of the electrodes produces no appreciable effect on shear strengths.

It is very important that equal amounts of refrigeration be supplied to each electrode for uniform results.

It is impossible to say offhand what size unit will be required for a given job. We make a line of units ranging from $^1/_4$ h.p. up to and including 10 h.p., but loads can only be determined from experience and welding knowledge. There is no easy formula.

Factors to Consider

The weld nugget should penetrate between 60% and 80% of the thickness of the overlapping joints. If the weld penetrates the surface of the sheet, no amount of refrigeration will keep the melting metal cool. A good weld will be stronger than an equivalent rivet and will provide a streamlined surface. A good weld is usually determined by experienced observation and by using frequent shear samples.

The current time required for an aluminum sheet weld is less than 1 cycle in duration. Prolonged heating at less intensity would cause sheet buckling and poor welds.

In portable gun welders we often cool the welding cables and also the welding transformer. It provides much longer equipment life and makes the welder entirely independent of water supply.

The Government and the armed services are going over to welded construction instead of rivets, in many cases. Some aircraft plants are much further advanced in their welding designs than others.

In summation, we have done a great deal of experimental work both in the laboratory and in the field, and have proved to our own rather critical satisfaction that when properly applied, refrigeration is very beneficial in resistance welding. Some jobs could not be attempted without it.

We want to again stress the importance of a thorough grasp of welding knowledge and technique.

Health Aspects of Welding*

By A. G. Cranch, M.D.,† in collaboration with B. L. Vosburgh, M.D.‡

THE purpose of this paper is to offer some practical points for the better protection of the health of welding operators. It is not intended as an exhaustive research document. The health hazards of welding may be classed as "real and unreal." The former should not be ignored, nor should the latter be allowed to cause undue alarm. The real hazards are not mysterious; they should be easily understood by any reasonably well trained operator and means for protection are available and effective when used.

A welding operator is usually exposed to all the general accident hazards common to the industrial field in which he is working. Structural iron workers, ship builders and the like are exposed to increased accident hazards. As a large proportion of welding operations are in connection with such work, this may be one reason for the common assertion that welding is a dangerous and unhealthy occupation.

Another possible source for the charge that welding is a health hazard is the circumstance that the formulas of most rod coatings are "trade secrets" so that there is an opportunity to indulge in all sorts of speculation as to the danger to health from the "secret" ingredients in these coatings. Actually very few coatings would appear to have introduced any important health hazards. As for the "mystery," most of these coatings have been patented. Not long ago the Bureau of Mines issued an Information Circular[1] giving much detailed information on the composition of welding rod coatings and fluxes. This was based on patent information, purposes served by the various ingredients and analyses of many typical coatings. This and other reports remove the "mystery."

A third and perhaps the most important reason for the assumption that welding is a health hazard, are the dramatic deaths which have been reported in a relatively few instances following massive exposures to welding fumes in strictly confined spaces without suitable protection for the operators. That such incidents do not reflect a general hazard is well shown by the fact that in the past three years the number of welding operators has increased some 400% and in the past ten years consumption of welding rods has increased some 2800% with scarcely any increase in such fatalities.

Until quite recently the health problems of welding have been approached from a speculative rather than scientific viewpoint. Unfortunately in a number of instances even medical men, apparently with little attempt to check exposures or weigh evidence available, have attributed an amazing variety of ills to welding exposures. These include digestive disorders and malnutrition, liver diseases, respiratory affections even including cancer of the lung, circulatory, blood and glandular changes including thyroid disease and Hodgkin's disease, various skin diseases, neurological changes, sterility, and various other complaints. A careful analysis of these reports generally shows little or no evidence of any connection with welding exposures. The agents usually blamed for these various ailments would ordinarily be present in entirely negligible concentrations, if at all.

Such substances as silica, asbestos, manganese, chromium, nickel, cobalt, various other metals and even iron have been given as "potential hazards" in welding fumes. These have been charged with directly causing ill health or serving to activate other conditions such as pneumonia, tuberculosis, etc. With the exceptions shortly to be mentioned, there seems to be no evidence to indicate that they are present in a form or an amount which would constitute a health hazard. Some have stated that welding operators "are dying every day, and others suffering permanent health impairment as the result of their work," and charge that no studies have been made to identify or control the hazards. Anyone at all familiar with the research which has been done and is still going on in this field will realize that such charges must be due to ignorance or prejudice. The very thorough study conducted by Britton and Walsh[2] and the experimental work and observations in this field by many other investigators[3,4,5,6] fail to show any excess of ill health among welding operators, or any outstanding type of illness among them.

The Real Welding Hazards

The real hazards peculiar to welding are essentially from: (1) radiation and (2) air contamination by gases and fumes.

Radiation presents the hazard of intense light, glare and of ultra-violet exposures. Probably all workers even casually acquainted with welding operations are familiar with the need for eye protection in this work. In the case of gas welding there is little, if any, exposure to ultra-violet rays, but only glare from too intense light. The eyes must be protected by suitable colored lenses. In electric arc welding there is not only the glare but enough ultra-violet radiation to call for a deeper shade of protective lens for the eyes, and also a face shield and protective clothing to cover all skin areas which might be exposed. At present no attempt will be made to go into details as to this form of protection, as these are easily available from a number of sources, especially the American Standard Safety Code for the Protection of Heads, Eyes, and Respiratory Organs.[7,8]

Hazards from radiation are not confined to the welding operator alone, but also involve his helpers and others working in the immediate neighborhood, usually considered to be within seventy-five to one hundred feet in the case of arc welding. Any workman within this

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† Industrial Toxicology Dept., Union Carbide and Carbon Corp., New York, N. Y.

‡ Medical Director, General Electric Co., Schenectady, N. Y.

area should be protected either with suitable goggles or by the use of screens. If screens are used they should be so designed as to interfere as little as possible with ventilation. Some types of operation can be done in ventilated booths, which may serve to reduce the hazard to others. Not only must direct rays be kept from the unprotected eye, but reflected rays must be considered. This invariably calls for the use of dull non-reflective paint on areas which may otherwise serve as reflectors.

Excessive exposure of the eye to ultra-violet radiation damages chiefly the outer structures of the eye, setting up conjunctivitis of varying degree. The damage is analogous to a blistering sun burn of the skin and if the exposure is severe very painful reactions will occur, with some temporary visual disturbances. Ultra-violet rays do not penetrate the lens or injure the deeper structures of the eye. Experimental cataracts have been produced in rabbits by prolonged exposure to ultra-violet rays, but in actual welding experience lens changes do not occur and optic nerve injury is impossible from a physical standpoint.

Before leaving the subject of radiation it should be mentioned that in welding there is no exposure to short waves like the x-ray. This has been demonstrated repeatedly by having welding operators carry dental x-ray films in their pockets. No systemic effects have been demonstrated as due to the radiation in welding, least of all sterility. This is mentioned because this charge has recently been revived in some quarters. It was originally made during the last World War and several investigations proved it to be unfounded. There is no valid evidence to support such a theory.

Gas Hazards

Among the much discussed hazards of welding are those due to gases. These gases may be essential to the type of welding as the oxygen and acetylene in oxyacetylene welding or they may be produced through the reactions occurring in the welding process as oxides of nitrogen, ozone or in some cases of imperfect combustion carbon monoxide. It is hardly necessary to state that oxygen as used in welding does not produce a health hazard. Misused, for instance, as a substitute for compressed air in ventilating small spaces, it may increase the hazard from burns, as any material will burn more actively in the presence of an excess of oxygen. Ozone, a "peroxygen," may be formed in the welding arc and in concentrations of over 1 p.p.m. may act as a pulmonary irritant. On leaving the arc, ozone rapidly ceases to exist as such and many investigators have demonstrated that even in confined spaces a dangerous concentration is not found in the air breathed by an operator. It is extremely doubtful that ozone is anything but a theoretical hazard in welding.

While speaking of oxygen, mention may be made of the hazard said to be due to "oxygen deficiency" from welding. This could occur only in very confined spaces, as in tanks or some of the small compartments in ship's holds, and the like. There may have been some accidents due to oxygen deficiency in such locations but in all probability investigation would show that this condition already was present in the area before welding operations were attempted. In the case of oxyacetylene welding where a certain proportion of oxygen is drawn from the atmosphere the welding flame will usually become entirely unsatisfactory for its purpose and the deficiency recognized before the oxygen reaches a level low enough to be dangerous to the operator. Also the heat generated by the welding operation under normal atmospheric conditions would usually be unbearable in a confined space before dangerous oxygen depletion occurred. "Oxygen deficiency," then can be put into the category of unreal hazard.

One not infrequently sees references to the toxic effects of unburned acetylene or the "impurities" present in acetylene gas. Acetylene is a simple asphyxiant gas not in itself a poison. It has had fairly wide use as an anesthetic. A hazard would exist only when the gas is present in such concentration as to reduce the oxygen in the air breathed so that not enough remained properly to supply the body. As the lower explosive limit of acetylene in air is about $2^1/_2$–3% it is evident that in the presence of a flame an explosion would result long before the concentration would appreciably reduce the available oxygen in the air. As for the alleged hazard from impurities—arsine, phosphine, hydrogen sulphide or ammonia—this purely theoretical hazard is based chiefly on early analyses of acetylene made from materials of foreign origin. No significant amounts are present in acetylene produced today from raw materials from North American sources. Recently tests were made for arsine in dissolved acetylene from four commercial producers and not even a trace was detected. The minute amounts of impurities sometimes found in acetylene are, of course, destroyed in the flame. The health hazards from acetylene and its "impurities" belong in the "unreal" class.

Gases formed in the flame or arc are the oxides of nitrogen, sometimes called "nitrous fumes." They are *not* nitrous oxide, but are nitric oxide and other higher oxides of nitrogen. In the concentration present in connection with welding they are so diluted as to be colorless. Under other conditions of exposure these fumes may present other hazards but in welding the real hazard is as a pulmonary irritant. Except in small rooms or in very confined spaces as in tanks, etc., no dangerous concentration would be likely to occur. Just what is a dangerous concentration has been undergoing considerable discussion in the last two or three years. The classic figure of 39 p.p.m. by volume in air admittedly was based on very limited observations but has proved a fairly satisfactory working standard. Just as much more extensive experiments were beginning to indicate that 70 p.p.m. or even up to 100 p.p.m. might be a safe limit for a day's work; others, on what basis is not clear, are advocating a "safe concentration" of only 10 p.p.m. Certainly a study of available evidence indicates that in welding operations concentrations of 50 p.p.m. or less have not produced symptoms, and that probably under many conditions this amount may be exceeded without harm. Protection will be discussed under fume protection.

Carbon Dioxide and Carbon Monoxide

Carbon dioxide is produced by the oxyacetylene flame and by the electric arc but never in concentrations of physiological importance. Carbon monoxide may be produced through imperfect combustion as when starting welding or cutting of cold material or through the combustion of organic matter which may be present on the surface to be welded, or in the coatings of rods used. There is considerable divergence of opinion on the degree of hazard from carbon monoxide in welding. A careful comparison of the various reports seems to indicate that the danger of a significant concentration is very slight under all ordinary conditions of welding. If standards of ventilation indicated by other features of the work are followed the hazard from carbon monoxide should be non-existent.

Probably the most discussed health hazards of welding are those due to fumes. These are chiefly metallic, from the material being welded or used as a coating on that material or in the welding rod or its coating. The composition of welding fumes is so varied that this furnishes a wonderful field for the discovery of hypothetical and unreal hazards. These fumes also are the source of some very real hazards. If proper precautions are taken to avoid the real and recognizable hazards the same precautions should eliminate the theoretical hazards. Welding is now in such general use and the number of metals and their combinations involved is so great that there are probably but few metals which may not be handled by a welding operator.

The most common complaint due to fume exposure is metal fume fever. This, often called "zinc chills," "brass founder's ague" and the like, is really a non-specific reaction which might come from any of a number of metal fumes. The most common source is zinc fume, from welding on galvanized material, or brass, or from using rods with a high zinc content. Zinc should not be considered "highly toxic," however, as this condition is an acute, self-limiting reaction of short duration and without known after-effects or complications. In a large number of those affected a considerable degree of immunity is established so that subsequent attacks are very mild or lacking altogether. The permissible limit for zinc fume in the air has been suggested as 15 milligrams of zinc per cubic meter of air. If this concentration is not exceeded it is unlikely that any cases of metal fume fever will occur.[6]

The most serious condition likely to result from metal fume exposure is probably lead poisoning. This is not a hazard common to all welding operations, but only in the relatively few cases where welding or cutting is done on material previously covered with lead paint, coated with metallic lead, or where lead has been introduced as an alloy as in certain steels. In such cases very definite protective measures will be required.

Next to lead ranks cadmium as a potential hazard. Lately cadmium has come into more general use as a rust-proof coating for steel in place of zinc. It enters into some alloys. The fume may produce a pulmonary irritation and edema resembling in many ways the effects from inhaling oxides of nitrogen.

A wide variety of other metals have been mentioned as injurious: manganese, chromium, cobalt, copper, tin, antimony, magnesium, aluminum, tellurium, vanadium, titanium, and many others. As encountered in welding fumes the amounts are usually definitely less than those known to have toxic effects, and it is doubtful if any reports alleging injury from these metals in welding can be substantiated. Manganese has been most frequently suspected, but a study of the reports of alleged effects fail to show any conclusive evidence and the amounts involved are below those known to have produced effects. The charge that even small amounts of manganese predispose to pneumonia is not borne out by the known experience of welding operators.

Other materials than gases or metals may create fume hazards through air contamination. These may be encountered especially in repair work on various tanks, vats, etc. Their presence calls for special ventilation.

There is one other source of real hazard which may be present in many operations involving aluminum or some of the "stainless" steels and alloy metals. This is from the presence of fluorides in many of the fluxes or rod coatings used for this work. Hydrofluoric acid may be formed and the fume if inhaled in appreciable concentrations or for long periods may cause considerable irritation to the nose and throat or even pulmonary edema.

Prevention

To sum up: The real hazards of welding are not many, are generally easily identified and protective measures are available and effective when used. These real hazards should not be minimized or passed by. Briefly they are due to:

1. Radiant energy—ultra-violet and visible light.
2. Oxides of nitrogen.
3. Metal fumes—lead, cadmium and zinc.
4. Fumes from organic residues or wastes.
5. Fumes from fluoride-containing fluxes and rod coatings.

Protection from radiant energy has already been outlined. Protection from the rest is almost wholly a question of ventilation. Various means of approach have been tried to establish standards for ventilation. Standards in terms of concentration of contaminant expressed in parts per million by volume for the gases or milligrams per cubic meter for metallic and other fumes have been suggested, as have standards expressed in number of air changes per time unit. Both methods have value and studies made along these lines have done much to solve some of the difficult points in ventilation requirements. Unfortunately, it is very difficult to obtain quickly and easily a determination of fume concentration on a given operation. Local conditions may also change the efficiency of measures based on rate of air change. Notwithstanding some of the practical difficulties in applying such standards in specific cases, several general rules on ventilation have been evolved which have proved to be of considerable help.

Various studies of present-day practice have been made which indicate that welding out of doors or in large shops seldom results in any serious air contamination except in the case of lead. In spaces of less than 1000 cu. ft. and especially inside tanks, ship holds, etc., special ventilation is necessary. Usually the exhaust of contaminated air is much more effective than an attempt to force fresh air into the space. In stationary locations this can generally be done with properly located exhaust fans or by the use of hoods and ducts to withdraw fumes as near as possible to their source. Portable exhaust systems have been designed which are adapted to field needs.

In the case of gases such as oxides of nitrogen, or the rare instances of carbon monoxide, if sufficient ventilation is maintained from the beginning of the operation and sufficient to insure good visibility and to insure a comfortable temperature there should be no gas hazard even in confined spaces.

If lead or cadmium fumes are present the only complete protection is by the use of air supplied masks. These are of three types—air supplied by special blower, air supplied from compressed air system and masks with larger hose without use of forced air supply. If compressed air is used from a general supply, special filters and pressure regulators are required. In the last-named type with no forced air supply the length of hose can seldom be over 50 ft. In confined spaces one of the above devices should be used. Out of doors or in large well-ventilated shops and for moderately short exposures, one of the filter type respirators approved by the Bureau of Mines for lead fumes may be satisfactory. In any confined space at least local exhaust ventilation is required when there is exposure to zinc or fluoride fumes, or to fumes from heavy deposits of organic wastes and sludge. Air supplied respirators offer, of course, the most positive protection.

Briefly, a minimum standard of ventilation is one that will be sufficient to insure good visibility at the point of

operation, and insure a temperature within a reasonably confortable limit. In confined spaces this would call for exhaust ventilation. In case of lead or cadmium exposures air-supplied masks are required. No serious hazard is apt to be present except in confined spaces or when lead is involved. Special standards for ventilation in welding of leaded steel have been given by Halley.[8] General requirements for ventilation are given in more detail in the reports of Tebbens and Drinker,[6] in Special Bulletin No. 5 of the U. S. Department of Labor, "Control of Welding Hazards in Defense Industries[9] and by Hemeon.[10]

Summary and Conclusions

1. Health hazards in welding may be divided into "real" and "unreal."

2. Real hazards should not be ignored or minimized. They are usually easy to recognize and effective preventive measures are available.

3. Unreal and hypothetical hazards are often alleged. If indicated precautions are taken to guard against the real hazards, the unreal will disappear entirely.

4. Hazards from radiation in welding are limited to eyes and skin. No systemic effects have been demonstrated. Means of prevention are well known and available.

5. Hazards from air contamination can usually be controlled by ventilation and in some instances, by respiratory protective equipment. Hazard from gas is essentially limited to oxides of nitrogen. Ozone and carbon monoxide hazards are of minor importance. Oxygen deficiency, if present, is usually not due to the welding operation but to other causes. Fume hazards for practical purposes are limited to fumes from lead, cadmium, zinc or fluorine, and rarely from organic wastes or sludges. Fumes from other materials, when present, are usually in non-toxic amounts, or would be removed by protective measures indicated for the well-recognized hazards just mentioned.

6. No reliable evidence has been presented to show that welding operators have any poorer health and accident records than other tradesmen working in the same environment, or that they show any characteristic type of illness which could be associated with their work.

7. That the health hazards due to welding exposures are not great and can be well controlled is evident from the enormous increase in welding and its applications without a corresponding increase in illness.

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The Contribution of Resistance Welding Control to the War Effort*

By H. L. Palmer†

Synopsis

This is a mechanized war that calls for improved and faster methods of fabricating both light and heavy-gage metals. This paper deals with the more recent developments in resistance-welding controls that have aided industry's war effort. Energy-storage resistance welding, of both the capacitor and inductor type, has been extensively developed as an improved tool for the welding of aluminum. Conventional a.-c. resistance-welding control has been expanded to meet the exacting requirements of welding the many new alloys made available for war use. A current regulator has been developed that will maintain constant current through the weld even though the line voltage may vary or the secondary throat conditions change. Special sequence controls are available to meet any cycle of power applications found necessary to weld and heat treat the material to be fabricated. The demand on overloaded lines can be reduced by means of power-factor correction.

Introduction

THIS being a mechanized war, the building of war machines has taxed to the utmost our metal-fabricating methods. The problem is manifold. First, many new and special alloys have been brought into common use; second, the fabricating must be of the highest quality to withstand the abuses of wartime operation; and third, the process must be such that it can be done by comparatively unskilled men or women at a rate in keeping with the rush requirements of war. The four common methods of fabrication are riveting, arc welding, torch welding and resistance welding.

It is not the intention of the author to go into the merits of one fabricating method over another, but instead to summarize the efforts and accomplishments of resistance-welding control manufacturers to keep resistance welding in the front line of the battle of production. These developments, except for the work done on certain armor-plate alloys, are the same as would eventually have been developed in peacetime, the difference being that several years' developments have been crowded into one. The gratifying part is that when peace comes these same developments will simplify and improve the production of peacetime commodities as well.

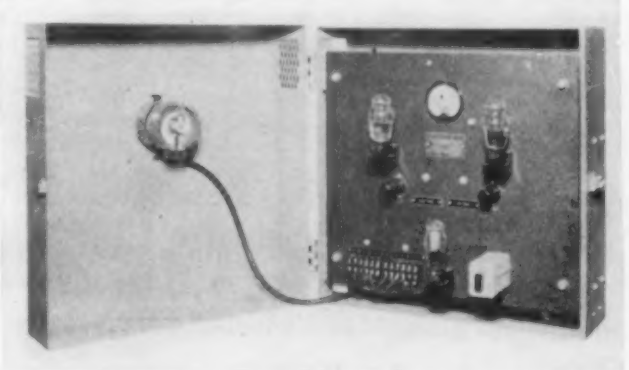
Energy Storage

In energy-storage welding, the power is drawn from the line at a reduced rate between the welds and then released into the weld when desired.

The increased use of aluminum alloys has renewed and speeded the development of two energy-storage welding methods; namely, capacity or electrostatic storage and inductive or magnetic storage. These two energy-storage methods have one important and undisputed advantage over the conventional a.-c. resistance-welding method, and that is the lower demand on the electric power system. There has also been presented much evidence of higher quality welds and lower electrode maintenance. The magnitude of these advantages must be weighed against the increased first cost. Energy storage welding is widely used and generally accepted for the production welding of aluminum alloys.

There is a dual power advantage. First, the duty cycle is reversed as the weld energy is absorbed over a longer time, therefore reducing the instantaneous kw. demand, and second, the power that is drawn can be divided over the three phases of the power system. In both energy-storage methods, the power is taken from the lines by a rectifier. Direct current from the rectifier is used to charge capacitors or to build up flux in an iron-core reactor. Then the energy in the capacitor is determined by the value of the capacitance and the square of the voltage to which it is charged. The energy in the inductance is determined by the value of the inductance and the square of the current flowing when it is interrupted.

The power impulse to the weld in either case is unidirectional and the wave shape can be varied by altering the circuit constants. The wave shape is changed to suit the requirements of the thickness and type of alloy being welded. This variable wave-shape requirement makes it necessary to build the control for the capacitor discharge welder with a range switch for changing the number of capacitors as well as providing the rectifier with a variable-voltage regulator.



Current Regulating Compensator for Use with Thyratron Resistance Welding Control

This compensates for variations in line voltage and for the amount of magnetic material in throat of welding machine.

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† Electronic Section, Industrial Control Engineering Dept., General Electric Co.

Electronic Voltage Compensator, Which Compensates for Variations in Line Voltage, as Used with Thyratron Resistance Welding Control

Power Control

The control of a.-c. resistance-welding machines consists of precise switching of the low power-factor load of a welding machine in accordance with the requirements of the welding technique for the job. This means that the problem can be divided into two parts: power switching, and timing or selecting. In addition to these general problems, specific welding requirements have demanded special controls. Examples of these are power-factor correction with series or parallel capacitors, current and voltage regulating compensators, and program welding for heat treating special alloys.

Functionally, the switching and timing technique has not undergone any major evolution. The standards are well established and the welding requirements for our present war effort, as well as for our past problems, can easily be met. The welding of heavy sections has required in some cases more current than can be handled by one pair of inversely connected ignitrons. By the use of suitable reactors and transformers, two pairs of ignitrons can be made to divide the load so that approximately double-demand kva. can be handled. In cases where the demand is not too high for one pair of tubes but the conduction is long or the duty cycle is high, two pairs of tubes can be used to divide the load by switching the load from one pair of tubes to the other at frequent intervals. In this way, the average current rating can be practically doubled. Thus, the control manufacturers have met the war demand for larger welders operated at higher speeds.

Current and Voltage Control

It has been an accepted fact that the presence of magnetic material in the throat of a welding machine decreases the magnitude of the welding current. Because of this, the heat control had to be changed as work progressed into the throat. Again, the use of heavy gage material aggravated this condition. In one case, the welding current would change as much as 30% from the first weld to the last weld. The control designers have now solved this problem with a current-regulating compensator.

If the current flow in a weld were continuous and no starting problem were involved, it would be a simple matter to regulate the current to a constant value. However, the conditions are such that the current must start and stop frequently and a conventional regulator will have a serious starting problem. This is because with no current flowing (which is the condition between welds), the regulator will advance the phase control in a vai effort to maintain the correct value of current when th circuit is open. When a spot is wanted and current starts to flow, the first half cycle will start early, giving full heat at least for one-half cycle and maybe more, depending on the speed of the regulator. This excess current at the beginning of the weld is disastrous to the work and the electrodes.

To overcome this problem, the regulating element is energized from a standby source adjusted to the current desired. In this way, the first half cycle is approximately correct or it can be purposely suppressed so as to start at a slightly lower than normal current. When current starts to flow, the regulating element is transferred from the standby source to the current transformer and regulates the current for the rest of the current-conducting interval.

An emission-limited tube is used in order to get a true measure of the r.m.s. current with various form factors that are present in phase-control circuits. The filament of this tube is heated from the current transformer and the plate current that will flow is a true measure of the heating value of the current in the current transformer. The regulating circuit is arranged to maintain constant current in the filament and the value of line current is controlled by changing the ratio between the filament current and the primary of the current transformer.

The above-described control is a true current regulator that will maintain constant current in the primary of the welding transformer with variations in the welding machine or variations in line voltage. It must be remembered, however, that the best the control can do is to advance the phase to a full sine wave or to retard it to approximately 20% current. Therefore, if wide variations are to be encountered, the normal operating point must be chosen very carefully.

If variations in voltage are the main source of welding troubles, a somewhat simpler control can be used that will vary the phase angle of the control from the normal setting in accordance with the line voltage. High voltage will retard the firing point and low voltage will advance it. This is a comparatively simple device, but is somewhat complicated by the fact that the angle necessary to correct for a given voltage change varies with the position of the heat control. For this reason, a sensitivity control must be gaged with the conventional heat control to inject the right amount of correction for the different heat settings.

Program Controls

The welding of air hardening steels calls for tempering of the weld so as to restore the weld's toughness. This is done with the work still in the welding machine immediately after making the weld; reduced current is passed through the spot for a sufficient length of time to raise the temperature to the annealing point. The welding engineers and metallurgists specify the required procedure to make the weld and to anneal the work to the control designer and the correct sequence of heat and cooling time is provided. The flexibility of phase control allows an almost infinite number of possibilities from which the metallurgist may draw. It is possible to change gradually the current from one value to another during a current conduction. In this way, the control engineer has made available to the metallurgist any cycle of conditions he may desire to properly handle the alloy being welded.

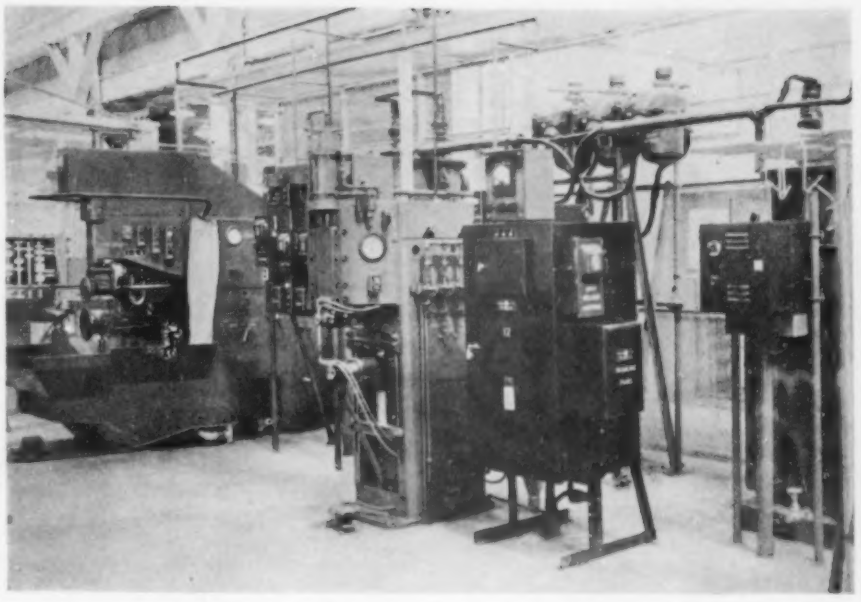
Reducing Kva. Demand

Some operating figures indicate that a spot weld costs 1/10 as much as a rivet. This means a saving in labor, material and time—all very important factors in the war of production. For this reason, there has been a great increase in the number of welding machines used in established factories. Since a large welding machine, especially when designed for welding aluminum alloys, is a low power-factor, high-demand machine, a number of those operating in the same plant tend to disrupt the plant's voltage stability—one welder may even interfere with another welder on the same line.

Troubles from this source have been reduced by the development of power-factor correction. Power-factor correction with series capacitors was described a few years ago by L. G. Levoy, of this Company, in a technical paper. Since then, many installations have been made and the results have been all that could be expected. Line-drop difficulties have been reduced by the use of welding controls designed to operate at 2300 v. The operation of welders directly from the 2300-v. line does not reduce the kva. demand but does reduce the line current and therefore makes the power distribution problem simpler.

In energy storage welding, as pointed out earlier, voltage stability is inherent. This method helps lighten the burden on power lines by:

1. Reducing kva. demand.
2. Dividing load over three phases.



Resistance Welding Installation Showing Welders and Associated Electronic Control Equipment

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The Soldier-Welder a Key Figure in War Effort

Martin M. Forman*

THE world populace today knows to what extent the outcome of the war depends on transportation. Even to the casual observer, transportation—or the lack of it—must mean ultimate victory or defeat. Synonymous with the word, transportation, comes the immediate picture of great fleets of trucks, ever-moving to the battlefront. For this is a battle of supplies, and that supply line must not be interrupted.

Of prime importance in this picture is the welder. With the vast number of trucks used by the U. S. Army in the domestic and foreign fields, little or no imagination is needed to realize the welder's part in the present-day conflict. Trucks on hand must keep going. A day lost off the road is too costly. And while time is limited, repairs must be durable. A breakdown in the midst of a convoy may easily prove disastrous.

At the Quartermaster Replacement Training Center, Camp Lee, Va., commanded by Brigadier General Guy I. Rowe, with Colonel James H. Johnson as Director of Motor Training, the soldier-welding specialist receives his training at the Blacksmith and Welding School. At the school, which is in charge of Capt. J. L. Bauer, the trainees are instructed in blacksmithing, oxyacetylene welding and electric arc welding.

When the welder is graduated—with plenty of practical experience attained at Camp Lee during his schooling period—to be turned over to Ordnance, you may be assured he is ready for his appointed task in camp or field.

The soldier-welder may find himself called upon to do jobs ranging from heating a bent bumper to free it from the tires, to repairing a cracked cylinder block. He may become a member of a light maintenance unit, the equipment of which includes a four-ton wrecker carrying a complete mounted oxyacetylene cutting and welding outfit used to cut away the debris caused by a wreck or to release drivers or cargo trapped in the wreck. Here also he may be called upon to weld tie rods, repair tail gates and other parts. Also to fabricate small parts, make body repairs, make special tools and repair broken

* QMRTC Public Relations Staff, Camp Lee, Va.

CAMP LEE, VA.—Soldier-Welders Are Taught to Be Proficient in the Use of Oxyacetylene and Electric Arc Equipment. A Trainee at the Quartermaster Replacement Training Center School, Camp Lee, Watches an Instructor in the Correct and Safe Manner of Employing a Torch

tools and equipment. He will also repair cracked cylinder blocks, heads and manifolds. The light maintenance company normally serving a division has three blacksmiths and welders and includes among other items such equipment as a gasoline-driven arc welder, and a portable forge.

The work of the foregoing unit is apt to be more of an emergency nature. Just enough to get the vehicle rolling again. The work in the heavy maintenance shop is of a more permanent and finished character. In this shop, equipped to serve a corps or army, the vehicle is expected to leave practically as good as new. Six blacksmiths and welders have at their disposal a gasoline-driven arc welder, a motor-driven arc welder, two oxy-acetylene outfits, two portable forges and their respective tool kits.

All in all the Camp Lee trainee is taught to fit in and be capable of doing any type of repair job that might be required. He must be able to offer suggestions. He must learn to take into consideration the service conditions, the strength of the part, the possible result of failure, the effect of heat and expansion, the effect of welding on prior heat treatment and any alternate methods of repair.

Capt. Bauer has been officer in charge of the school since its inception at Camp Lee in February 1941. Then a Second Lieutenant, he came from a position as engineer in the maintenance and construction department of the Standard Oil Company of New Jersey. He had an open yard for his shop, a trailer for his office, and for a time his own "sticky" portable—as he describes it—was the only typewriter. It was an inauspicious start, to say the least. However, he was blessed by having assigned to him as assistants two civilian instructors who were experts in their line. One was Mr. Lyle Jordan, now a commissioned U. S. Army officer on overseas duty, and the other, Mr. Joseph Rutledge, who has since worked on the Burma Road and is now somewhere in the Far East in the government service.

At first the only equipment on hand were a welding torch and a single gas-driven arc welder. Salvaged C.C.C. trucks began to arrive by freight from the entire country. These vehicles, with bodies removed and cabs cut off at the cowl, arrived in gondola cars. Unloaded with a crane they were put in the salvage yard. Owing to the delay in obtaining the crane from the contractor who was building Camp Lee, the cars sometimes waited in the freight yards for several days. Later on to avoid this delay, the staff constructed a derrick, mounted it on a Corbitt 6 x 6 and used it for this purpose.

With the assistance of the enlisted cadre, the task of making units for the various motor shops began. An engine stand was devised, using the chassis frame, and using the cross members for legs. Thirty-one unit shops needed ten engines, one stripped chassis, one front and one rear axle as well as transmissions, differentials, steering gears, etc. A quota of five engines per shop was set up as a start as sufficient chassis were not available to provide the full number.

The work was accomplished on schedule, although a comparative short time was allowed. The maximum production on one day was 28 stands. After the design had been decided on, a regular production line was started. The frames were cut in the field and the cowl, bumpers and springs removed with cutting torches. Then the engine and frame were taken to the welders on homemade dollies, and the stand completed. The successful completion of this mission was only possible through the determination of all the personnel, officers, civilians and enlisted instructors, who worked through the cold, rain and mud to complete the task.

With no buildings available for the storage of equipment, the arc welders were mounted in 1-ton trailers and covered with tarpaulins at night. Tent flies were set up to provide a measure of protection from the rain, and later a combination cargo and horse trailer was used as a tool and supply room. By July, with the training of soldier students underway, Capt. Bauer had accumulated several tents and two huts of the type used by contractors. But long before it was moved into a building in November 1941 to share a shop, the blacksmith and welding section was a busy one. Twelve arc welders were in use. To make them portable they were mounted on chassis made from salvaged parts. This made it possible to tow them around as needed, and many jobs were done away from the shop.

Welding tables and stands for both arc and acetylene welding also were made from salvaged material. Many of the trainees proved to be expert welders and they were used as assistant instructors. The classes were divided into two groups, arc and acetylene, and interchanged at the end of the predetermined period. The students were first taught to weld on scrap material, and after they became proficient were put on the production of the many articles needed for the basic school. Axle, transmission and transfer case stands were made and many repair jobs done for the Post Quartermaster, the various motor pools and other organizations. Among the items repaired were three motion picture machines for the post theaters. Two road sprinklers were made from old gasoline tankers, and road drags from railroad rails. Recently the production area designed and made a tree mover.

The Blacksmith and Welding School expanded to such proportions that it was assigned its own shop building in July 1942. The next month, another building was added to the school—the blacksmith shop, designed by Capt. Bauer. Here the trainees made the tools for the school as they learn the operations of the anvil and the forge. The main building is an industry in itself, with the large equipment comprising fifteen gasoline-driven d.-c. welding generators and four electrically driven d.-c. welding generators.

Assisting Capt. Bauer are Lt. C. J. Clements; Staff Sergeants Charles Mouser and Vincent Maculaitis; Sergeants Charles Niederlander, Eugene Kaminsky and Carl Rowe; Corporal Augustus Abrams; and 14 civilian instructors.

Office Chair*

By Eldridge T. Spencer†

Design

WHEN the Chemurgic Corp. finished its chemical industrial plant at Richmond, Calif., in 1941, the owners began looking for a chair that they could use in their administrative offices. These were housed in a completely functional, modern streamlined building. The chair was to be used at long stationary desks fitted with demountable extension wings. It was to be adjustable in order to accommodate slim girls as well as two hundred-lb. men. Since men and girls often changed places all adjustment was to be quickly made. In addition the chair was to be easily movable from side to side and back and forth to allow for work at the desks when the extension wings were in place. For economy of space the chair was to be compact. For economy in cost it was to have no extraneous detail or ornament. For economy in maintenance it was to be durable and the parts easily replaceable.

After experimentation it was decided that the easiest adjustment to make for height of occupant was the backward and forward sliding adjustment of seat that is used in the driver's seat of an automobile. Therefore the seat was made to slide on the 2 side pipes of the supporting frame and held in place by means of a butterfly nut. As in an automobile this adjustment could be made while sitting in the chair. (Fig. 1)

An adjustment of the back was made also, both for height of occupant and for posture. In recent years employers have become aware of the importance of posture particularly in the case of sedentary workers whose posture depends largely on the chair provided by the employer. For good posture the back of the occupant must be constantly supported in an upright position. This means that the angle of the chair back should change as the occupant leans forward or back. In the chair under discussion a straight back revolves on a swivel joint nine inches above the seat of the chair. As the occupant leans forward the back follows and vice versa. Furthermore, though the back is symmetrical top and bottom, the point at which it swivels is offset 1 in. from the horizontal center. This makes it possible to raise or lower the top of the back 2 in. simply by revolving it one 180°. To add comfort to good posture seat and back are cushioned with 2 in. of foam rubber.

The chair is compact. The arms extend only $10^1/_2$ in. from the line of the back, far enough to give support and not far enough to interfere with easy access to the lower compartments of the desk. In fact all parts of the chair are made as small as their proper functioning permits. Front legs are perpendicular and set just back of the front line of the seat. Rear legs which extend upward to support the arms are snubbed in at the base so as not to occupy too much space. So that the chair may move easily as the occupant turns from side to side or pushes back, it is fitted with 2-in. commercial rubber casters which roll noiselessly over a smooth concrete floor kept at a comfortable temperature by radiant heat.

In addition to being easily movable, compact, comfortable and easily adjustable thus fulfilling the requirements of function, the chair fulfills other requirements of good industrial design, namely, that materials be used efficiently and frankly and that good engineering be synonymous with good esthetics. Considering first the use of materials, the frame only is of pipe chosen for strength and availability. The frame has no moving parts. The frame is a good example of precision design made practicable by arc welding assemblage. It is the frame that is entered in competition. The seat and back are of plywood chosen for relationship of strength to weight and size and for ease in cutting. Seat and back are cushioned in foam rubber chosen for comfort and simplicity of assemblage and upholstered in mohair frise chosen for durability and considered preferable

Fig. 1—This Office Chair Pipe Frame Was Assembled by Means of Arc Welding

* Third Prize Award paper in the Furniture and Fixtures Division of the 1940-42 Industrial Progress Award Program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, O. The award papers showed a possible saving of $1,825,000,000, including 7,000,000 tons of steel and 153,000,000 man-hours of labor available by application of arc welding.

† Architect, San Francisco, Calif.

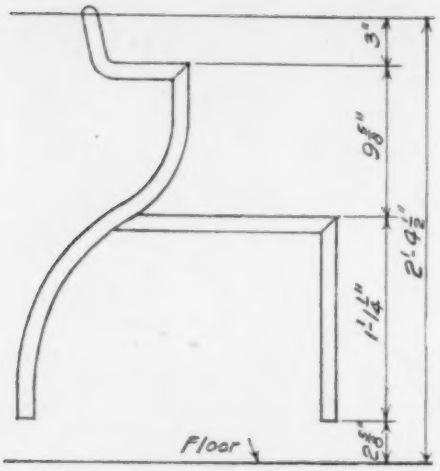

Fig. 2

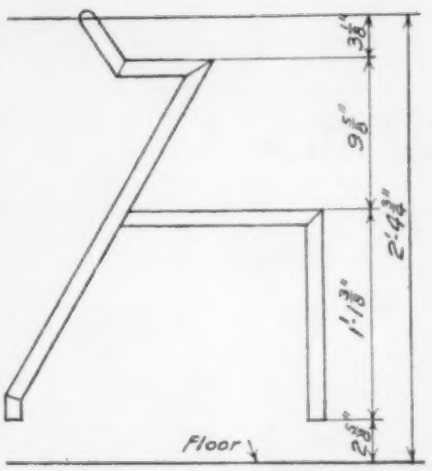

Fig. 3

to leather or fabricoid since mohair decreases wear on clothes and does not tend to stick in hot weather. Arm rests are of wood used because wood is warmer to the touch than is metal. The chair could be complete without casters.

Considering the requirement that good engineering be synonymous with good esthetics, the chair has style. That which has given it style more than anything else is the solution of the problems of manufacture and the use of arc welding. Indeed, without welding, it would be impossible to realize the full engineering and style possibilities of the pipe. For comfort, the arms, at the point where they are supported by the rear legs, are 3 in. farther apart than are the legs where they meet the floor. For facility of manufacture, rear leg, arm support and back support are on one plane so that the pipe can be placed in a jig and quickly tacked by arc welding. This being the case, as legs are brought together at the floor, arms slant outward giving the chair an inviting air.

The definition of planes is made as precise as possible and the number of planes reduced in the interest of fabrication first and of style its inevitable counterpart second. The planes are 6: those of the rear legs, arms and back support, that of the rear legs and stretcher, introduced for strength but contributing to style, the plane of the back, the plane of the seat and the plane of the front legs.

The pipe frame has a baked enamel finish. The walnut arm rests a varnish finish over bleach to harmonize with the wood of the desk tops. These high polish finishes are durable, easy to maintain and contrast pleasantly with the texture of the mohair back and seat. The pattern of the upholstery is geometrical and appropriate for a chair whose style depends on precision engineering. It is based on diagonals and realized in texture rather than in color. Color, both of mohair and of pipe is a slightly grey Copenhagen blue, the same color that is used on the steel sash of the windows of the offices where the chair is installed.

Fabrication

The frame of the chair is constructed of $^3/_4$-in. commercial steel pipe chosen for its strength and availability. At the time of fabrication there was thought of using tubing. However this was not obtainable. To the delight of the designer, the weight of the chair, 30 lb. has given it stability and reduced the hazard had a lighter tubing been used of the chair skidding out from under its occupant. Furthermore, since the chair never has to be lifted, the weight is in no way a detriment.

The chair has 18 welded joints, all of which join only 2 pieces of pipe, never more, to simplify fabrication. For example, front support of chair seat joins with side supports just back of joint of front leg with side support. From the point of view of fabrication, design and style, the most interesting part of the chair and of the chair frame is the rear leg, arm and back support. The four pieces of pipe forming this member were placed in a right-hand jig, tacked with an arc weld, then placed in a left-hand jig and tacked again. Once these members were assembled they were held in place with spacers and the back support of seat and the stretcher welded in place. The whole design of the chair depends on the accurate alignment and rigidity of this portion of the frame, for the frame, at the points of support of the revolving back, must not only be strong but must never vary in width. To prevent any tendency of these points to spring apart the back stretcher was introduced. To secure speedy and perfect alignment arc welding was necessary.

Two chairs having the same functional requirements were designed for the Chemurgic Corp., the first in 1941 and the second in 1942. The chairs were identical except for the form and construction of the rear leg, arm and back support, which in the 1941 chair consisted of a curved pipe as shown in the drawings. In the 1942 chair, costs were cut and time of fabrication reduced when the curved pipe was replaced by straight pipe and two additional welds. (Fig. 2.)

Bending pipe in the 1941 chair cost $2.00 per rear leg, arm and back support. The additional two welds in the 1942 chair cost $0.50. The difference, $1.50 per rear leg, arm and back support, or $3.00 per chair is the savings made by the change in design and fabrication. As the pipe frame of the 1942 chair cost $15, this savings amounts to 20%. An additional savings of 28% was made in the time of fabrication as the 1941 chair frame having curved pipe was more difficult to assemble. It is interesting to note that the improvement in the 1942 chair was due to lack of equipment to build the first chair, as the pipe-bending machine used in the fabrication of the 1941 chair was in use in 1942 in the airplane industry. The result was a better, cheaper chair that could be fabricated in any shop equipped with a pipe cutting saw and an arc-welding outfit. (Fig. 3.)

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THE AMERICAN WELDING SOCIETY

ACTIVITIES – RELATED EVENTS

BOARDMAN HONORED

At the invitation of Dr. Joseph P. Connolly, President of the South Dakota State School of Mines, Rapid City, S. D., Mr. H. C. Boardman gave the Commencement Address at the School on the evening of January 29th, and at that time an honorary degree of Doctor of Engineering was conferred upon him.

H. C. Boardman

Mr. Boardman is a Past-President of the SOCIETY, recipient of the Miller Medal, Vice-Chairman of the Welding Research Council, chairman of the University Research Committee.

MARITIME PRODUCTION WELDING COURSE HELD IN CLEVELAND

The second of a series of special courses in production welding for men from shipyards building boats for the Maritime Commission has just been completed.

Held at The Lincoln Electric Co., Cleveland, Ohio, the series of courses is designed to assist the shipyards to increase their welding production and thus speed the launching of badly needed cargo boats.

The Maritime course is one week in length and in the two courses which have already been held, shipyards from all corners of the country have been represented. During the two meetings, one man from the Maritime Commission and fifty-nine men from a number of shipyards have attended.

Procedures for all kinds of arc welding being done in the shipyards are not only studied but are actually practiced and perfected. The mornings are devoted to lectures, demonstrations and conferences, while the afternoons are spent in the welding of typical shipyard joints.

WIRE ASSOCIATION ELECTS OFFICERS

The Annual Directors Meeting of the Wire Association was held at the Waldorf-Astoria Hotel, New York, N. Y., on Saturday, March 27, 1943, and at this meeting the following officers were elected for the forthcoming year:

President—Carl E. Johnson, Supt., Rod & Wire Mills, Bethlehem Steel Co., Sparrows Point, Md.

Vice-President (Steel Div.)—D. D. Buchanan, Manager of Operations, Union Drawn Steel Div., Republic Steel Corp., Massillon, Ohio.

Vice-President (Non-Ferrous)—E. W. Clark, Mech. Engr., Wire & Cable Section, General Electric Co., Schenectady, N. Y.

Executive Secretary—Richard E. Brown, Publisher, *Wire & Wire Products*, Stamford, Conn.

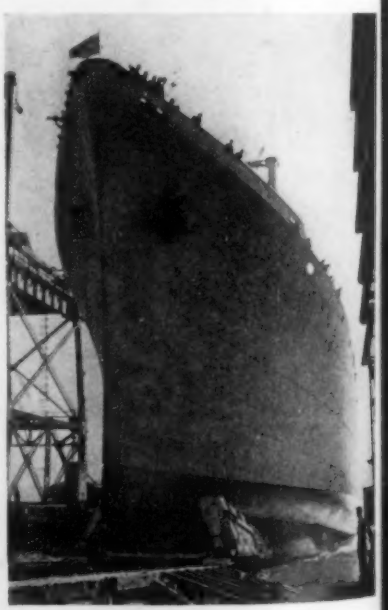
Plans were laid for the 1943 Annual Convention of the Wire Association which will be held this year in conjunction with the National Metal Congress and the American Society for Metals at Chicago, Ill. on October 18th to 22nd. The headquarters of the Wire Association will be at the LaSalle Hotel where all meetings, the Annual Luncheon and the Annual Smoker-Dinner will also be held.

The Chairman of the Program Committee as selected by the Board of Directors will be A. M. Reeder, metallurgical engineer of the Jones & Laughlin Steel Corp., Pittsburgh, Pa., and the Vice-Chairman in charge of the non-ferrous activities will be E. W. Gundstrom, Asst. Plant Manager of the Rome Cable Corp., Rome, N. Y.

NAVAL SHIPS GIVEN MOUNTAIN NAMES

The launching of the U.S.S. *Blue Ridge*, shown above, and the U.S.S. *Rocky Mt.* shortly afterward on March 7th at Kearny, N. J., sent into the water two of the first naval ships to bear mountain names. The ships were sent down the ways from the Kearny shipyard of U. S. Steel's Federal Shipbuilding and Dry Dock Company. They were converted on the ways from C-2 type cargo vessels to ships for special Navy duty. The U.S.S. *Blue Ridge* was sponsored by Mrs. David Arnott, of Short Hills, N. J., wife of the Vice-President and Chief Surveyor of the American Bureau of Shipping. The U.S.S. *Rocky Mt.* was christened by Mrs. Robert C. Lee, of Far Hills, N. J., wife of the President of the Propeller Club of the United States.

Mr. & Mrs. David Arnott



U. S. S. Blue Ridge

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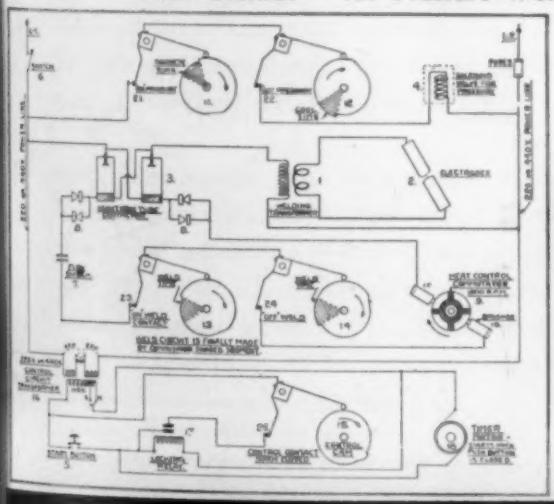

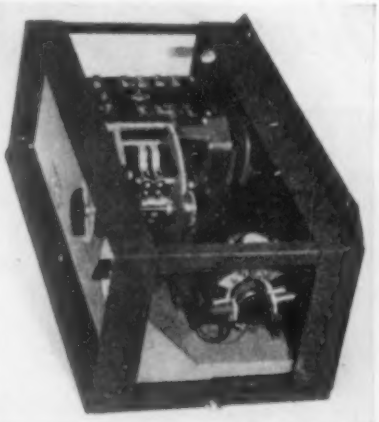

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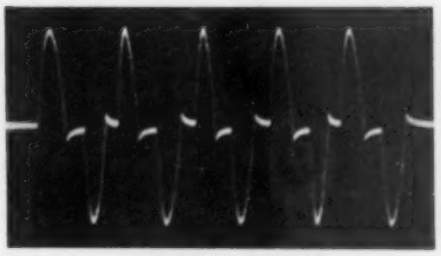

A 5 Cycle Oscillogram of Weld Current, showing Heat Control, or Delayed Firing.

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HARD-FACING BULLETIN

A very interesting pamphlet on the use of hard facing in the restoration of worn parts to original dimensions by means of a welded overlay of exceptionally wear-resistant alloy is issued by Coast Metals, Inc., 1232 Camden Ave., S. W., Canton, O. Copies of this bulletin are available on request.

WORLD'S LARGEST SEAMLESS WELDING ELBOW

Now in production at Tube Turns, Louisville, Ky., is a 30-in. seamless welding elbow to be used in sea-going drydocks for the U. S. Navy. These are the largest seamless elbows ever made and, doubtless, these enormous drydocks are the largest floating structures ever known as, in all probability, they will float our newest 35,000-ton battleships. Under their own power these monsters will follow the fleet to battle areas where they will facilitate below-the-water-line repairs on all fighting ships and battle fleet-servicing ships. "Wounded" battleships, carriers, cruisers, submarines, destroyers . . . down to transports, supply ships and tankers will be saved which otherwise would sink before they could get back to a base.

A floating drydock is essentially a huge, hollow platform that partly submerges, by letting water inside, until the ship to be serviced is floated above it. Then it rises, by pumping out the water from its hollow interior until the ship is no longer afloat. Batteries of large pumps will pump the water out—through the 30-in. welded pipe lines made with these huge elbows.

The Grand-Daddy of Them All, 30-In. I. D., the Biggest Welding Ell Ever Made by Tube Turns, Louisville, Ky.

This 180 return can be used as such but in this instance will be cut apart into two 90 ells, for use on huge, self-propelled floating drydocks now being constructed by the U. S. Navy. A baby turn, a half-incher, is held up for comparison.

By using this welded construction the Navy saves erection time and weight and gains for these drydocks the same superior piping that the newer fighting ships now have. This piping has exactly the same aperture all around the curves that it has on the straight-aways and no obstructions—gives maximum flow and efficiency. With this piping maintenance is practically eliminated as the weld is stronger than the pipe. Even vibration from bombing, shelling or torpedoing, which in other piping causes leaks far from the explosion point, will not affect it.

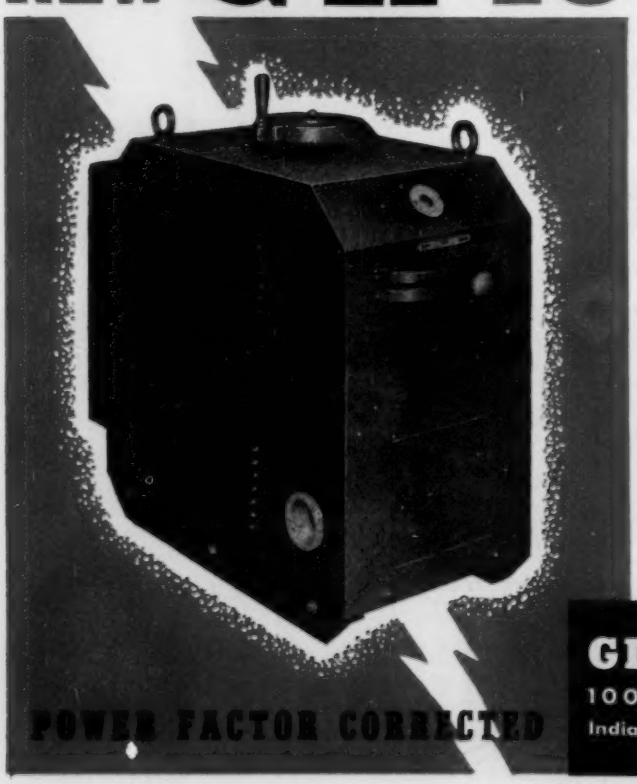
Manufacturing excellence has been retained in this grand-daddy-size elbow; uniform thickness, absolute circularity and extra strength gained by the exclusive forging process itself. Though walls are no thicker than those of the pipe, these fittings are stronger, better steel—better able to withstand the extra strains to which the curves, or turns, of piping are subjected. Accurately machined, they facilitate exact alignment and perfect weldings.

BULLETIN ON HARD-FACING

A bulletin, description of their hard-facing material "No-Wear," has just been released by the Callite Tungsten Corp.

The NEW G-R 45 MEETS WAR DEMAND FOR WELDING TOUGH ALLOYS

... with advantages of A-C Transformer-Type Welding



ARMOR-PLATE and tough alloys present special welding problems. G-R has met the demand fully with this new heavy-duty A. C. manual welder incorporating new characteristics.

Heat control is infinitely variable throughout an extreme range...from 20 to 625 emperes! Efficiency is high, power factor correction standard. G-R 45 handles heavy war work with ease, yet may be adapted instantly to the fabrication of light metals . . . an important advantage when peace brings the changeover to consumer products.

Talk with your nearest G-R Distributor or write, wire or telephone

GLENN-ROBERTS COMPANY

1009 FRUITVALE AVENUE, OAKLAND, CALIFORNIA

Indianapolis, Ind.: P. O. Box 1556 · Washington, D. C.: P. O. Box 1814

Victor No. 1

Over 15,000 Combination Welding and Cutting Units like the one here illustrated now enter the services of our armed forces.

This VICTOR Aircraft Maintenance Unit No. 1 has been specially designed to meet the most stringent specifications for operating accuracy, maintenance simplicity and trouble-free service life.

A 64-page, multi-color, VICTOR Apparatus Catalog will gladly be furnished, free of charge, upon request.

VICTOR EQUIPMENT COMPANY

844-854 FOLSOM STREET • SAN FRANCISCO, CALIFORNIA

This bulletin, No. 153, describes the advantages and physical characteristics of "No-Wear," for hard-facing. Methods of application and typical uses for this material are also detailed. A copy of Bulletin No. 153, entitled "No-Wear Metal," can be had by writing to the main office of the Callite Tungsten Corp., Union City, N. J.

SILVER ANNIVERSARY OF ELECTRIC ARC, INC.

A quarter of a century has passed since the Electric Arc Company was organized as a N. J. Corporation, on St. Patrick's Day, 1918, taking over the patents of C. J. Holslag, from the Steinback Electric Co., of Peekskill, N. Y.

The country was at war then, as now, and the Electric Arc Company furnished many of the welding machines used in the Fabricated Shipbuilding Program of World War I, as well as other uses.

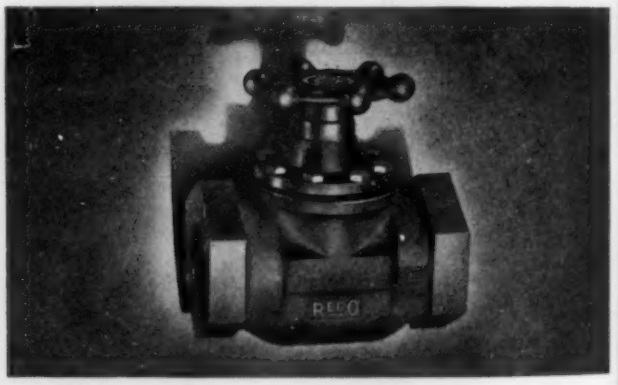
The Electric Arc Company pioneered in electrode coverings, which, more than any other factor, has helped arc welding achieve its present prominence.

It is now engaged in promoting the use of electric induction preheating, normalizing, bending and stress relieving, and in its newest development, the Group Multiple Star System, wherein the arc starts on d. c. and runs on a. c., thus giving the desired features of both systems.

Electric Arc Inc. Celebrates Its 25th Birthday

Mr. Holslag, the President of this Company, has received the Miller Medal and the N. A. M. Silver Placque for contributions to the Industry and is ably assisted by: Clark Kenlan, Chief Engineer; Fred B. Swankhous, Mechanical Engineer; Otto Kreisel, Electrical Engineer; Bernard A. Sternberg, Sales Manager; and John Coffin, General Superintendant. With him for the entire period is John E. Gunning, Financial Vice-President and A. D. T. Libby, Secretary and Patent Attorney. Good Luck Electric Arc, Inc.!

Is this YOUR Cleaning Problem?
How to Recondition Flame Cutting Tips Easier
For reconditioning fouled gas welding and flame cutting tips EASIER and FASTER, try the NEW, SAFE Oakite method specially designed for this work.
You will find it not only helps you SAVE TIME and CONSERVE MANPOWER by eliminating the need of manual buffing and scraping, but also speedily and thoroughly removes ALL tarnish, scale, slag and carbon without harming orifices. Write for NEW, FREE, 2-page Special Service Report giving complete details.
OAKITE PRODUCTS, INC., 18E Thames St., NEW YORK
Technical Service Representatives Conveniently Located in All Principal Cities of the United States and Canada
OAKITE
Done Proudly for Victory
CLEANING



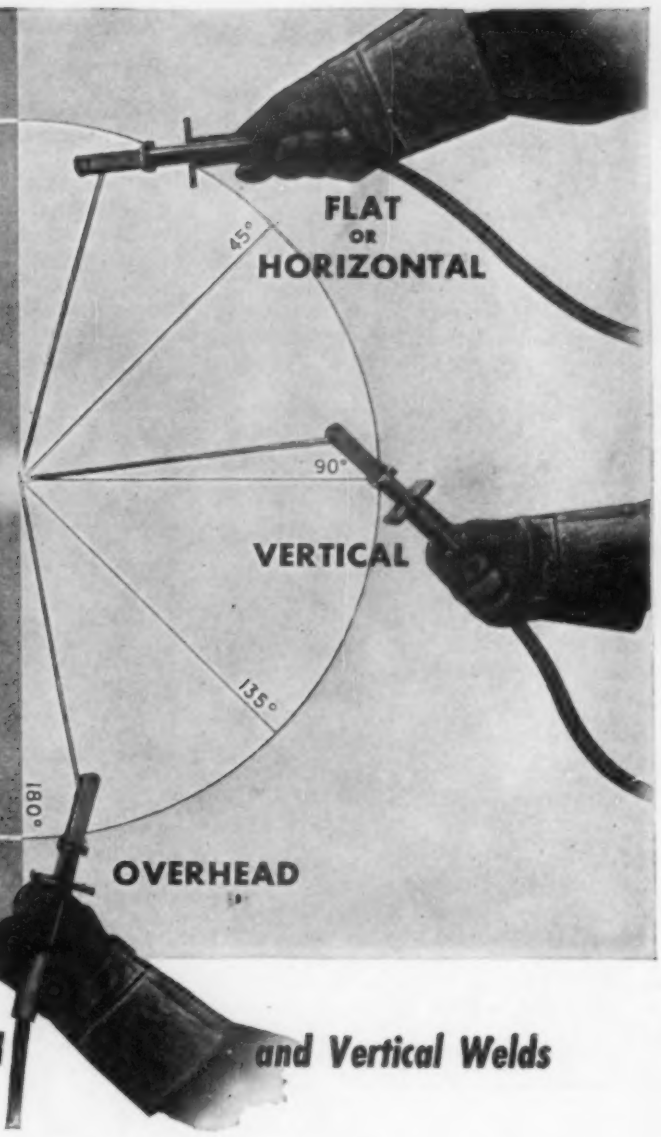
BRASS MAKES BULLETS

REGO Gas Plant Equipment to be safe, must be made of brass and other critical metals.

Conserve equipment—You may not get more.

The BASTIAN-BLESSING Co.
4241 W. PETERSON AVE. CHICAGO
Pioneers and Manufacturers of Precision Equipment for Using and Controlling High Pressure Gases

New All-Position A.C. Electrode MUREX TYPE A



Extremely Easy to Use for Overhead and Vertical Welds

Operators will like this new Murex Type A electrode because it is so easy to handle—in vertical and overhead positions as well as flat and horizontal. The molten pool is easy to control, and the slag easy to remove. Strong, uniform welds having complete fusion and good penetration are produced with characteristic A.C. speed and economy. X-Ray photographs show clean weld metal without gas or slag inclusions. Welds are smooth with no undercutting. ¶ Murex Type A electrodes meet the requirements for Grade E-6011 electrodes under A.W.S.-A.S.T.M. specification A-233-42T; for grade III, classes 1 and 2 under U. S. Navy Bureau of Ships Specification 46E3; and for grades H1G, B1G, and E1G, American Bureau of Shipping. ¶ Type A is available in 3/32", 1/8", 5/32" and 3/16" sizes. Typical physical properties of the weld metal, as welded, include yield points of 52,000 to 61,000 lbs. p.s.i., ultimate strengths of 62,000 to 71,000 lbs. p.s.i., and elongations of 22% to 26% in two inches. Type A is also usable on direct current, reverse or straight polarity.

New Murex Catalogue just printed. Contains complete descriptions of Murex electrodes. Send for your copy.

METAL & THERMIT CORPORATION

Specialists in welding for nearly 40 years. Manufacturers of Murex Electrodes for arc welding and of Thermit for repair and fabrication of heavy parts.

MUREX ELECTRODES

120 BROADWAY, NEW YORK

ALBANY • CHICAGO • PITTSBURGH
SO. SAN FRANCISCO • TORONTO

ELECTRONIC TUBES HELP SEW WARPLANES

American warplanes can now be sewn together, at speeds as fast as 1800 welding "stitches" a minute, with the aid of electronic tubes much like those in an ordinary radio set, Edwin H. Vedder, a Westinghouse engineer, reported recently at a meeting of the Pittsburgh section of the American Institute of Electrical Engineers.

Peak production in airplane plants, according to Mr. Vedder, manager of the electronic control section of the Westinghouse Electric & Mfg. Co., depends upon resistance welding, a speedy new process that stitches metal together just as an electric sewing machine runs down a seam.

This fast method of fabricating aluminum and stainless steel for planes depends upon precise control—and that is now being supplied by electronic tubes that have no moving parts to get out of order. Some of these tubes act as switches, jumping into action in one twenty-five hundredth of a second to start the weld. Previous methods of starting the weld were many times slower than this. Other tubes measure out electric power in exact doses to make each stitch uniformly strong.

Resistance welding, he explained, is done by machines which have water-cooled copper jaws that bite down to hold together the two piece of metal being welded. Then electricity shoots through the jaws and into the metal, creating heat to weld the two inner surfaces tightly together. On some jobs the jaws are replaced by copper wheels that roll over the metal, making continuous seam between the two pieces.

Some metals used in aircraft, Mr. Vedder explained, are so difficult to weld that a fingerprint on their surface will increase the metal's resistance, create more heat and noticeably effect the strength of the seam. That is why the length of the time the electric current flows must be regulated so precisely—sometimes to within less than a hundredth of a second. Such a division of time is easily measured out by electronic tubes which have no moving parts and thus no mechanical delay.

ALLOY METALS FINDING LIST

Time today means more than money in adapting business to changing conditions. Days, weeks and even months would be required to collect the preliminary information on new materials and new methods that have been developed from War Production Experience and now being compiled for ready reference by Hobart Brothers Company, Troy, Ohio.

Hobart is offering this unique service covering special information and new developments in metals, to help engineers, designers, metal workers and purchasing departments, as another contribution to progress of the welding industry.

Briefly, here's what the service will cover: The New NE Alloy Steels—New Building Specifications—Elements in Alloy Steels—Welding Nichrome Alloys. The first in this series of bulletins being compiled is the Alloy Metals Finding List and List of Sources.

BRAZING CATALOG

A new and revised edition of the general catalog on Sil-Fos and Easy-Flo brazing Alloys has been issued by Handy & Harman, 62 Fulton St., New York. Copiously illustrated and brimful of technical information and examples. Copies are available upon request.

HOSE CART ARC WELDED FROM SCRAP MATERIAL

A practical application of electric arc welding to fabricate a hose conveyor from scrap material (see accompanying illustration), was described in a letter from Albert Wunderlich, welder of Telluride, Colo., to A. F. Davis, Vice-President, The Lincoln Electric Company, Cleveland, Ohio.

According to Wunderlich, welders of the Telluride Mines, Inc., constructed a lightweight hose cart from various lengths of piping and two discarded wagon wheels.

In describing the welded construction used on this job, Wunderlich pointed out that the reel of the cart was made of a length of $^{3}/_{4}$-in. pipe babbited on the ends to fit the axle, with cross bars of 1-in. pipe welded to the spokes of the reel.

Two $^{1}/_{2}$-in. plates were welded to the tongue handle for connecting the cart to a motor truck for long hauls. The handle itself was of $^{3}/_{4}$-in. pipe welded to the front of the tongue, and the framework consisted of 2 x 2 x $^{1}/_{4}$-in. angle iron bent at the corners and then welded.

Shielded arc electrode was used throughout.

MALLORY STANDARDIZED WELDING ELECTRODES

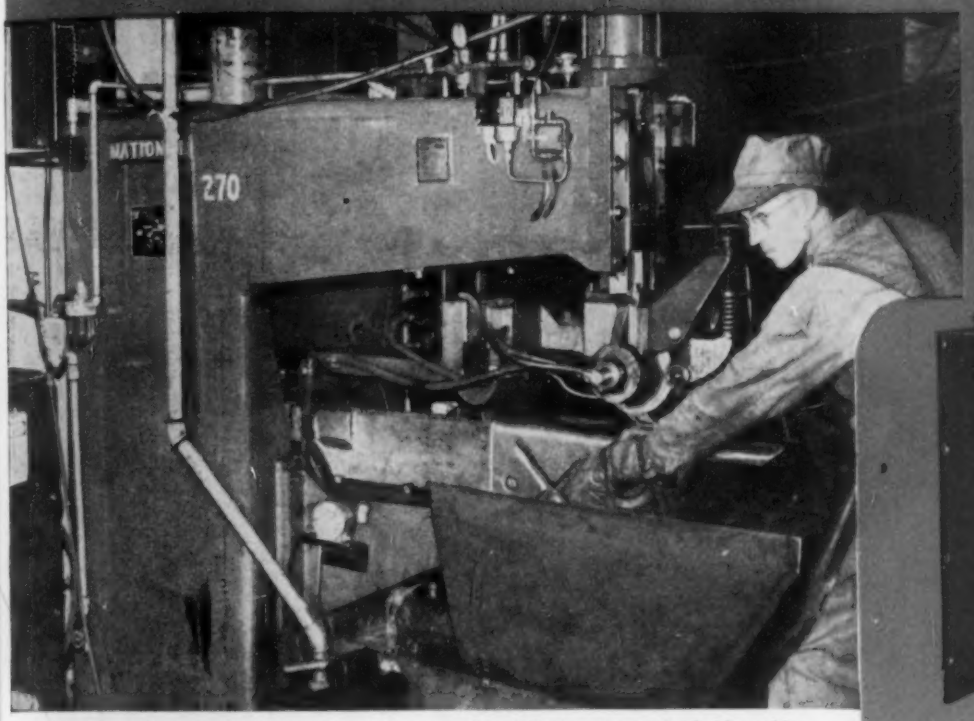
SPEEDIER PRODUCTION
LESS DOWN TIME
BETTER WELDING
LOWER COST

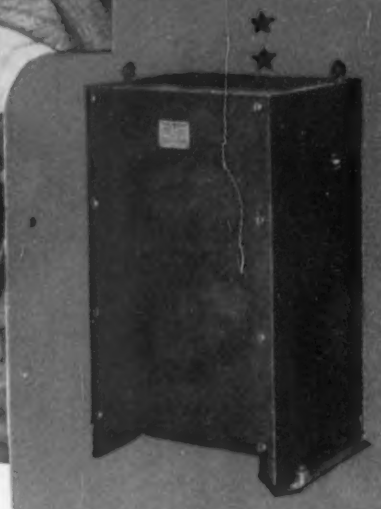
Spot welding speeds plane production. Seam welding speeds shell production. Flash and butt welding speed tank and jeep production. Mallory tips and holders, wheels and dies speed resistance welding all along the production front. Write today for your free copy of the factual Mallory Resistance Welding Data Book.

P. R. MALLORY & CO., Inc., INDIANAPOLIS, INDIANA • Cable Address — PELMALLO

TO REDUCE KVA DEMAND OF RESISTANCE WELDERS

USE G-E PYRANOL CAPACITORS





Series-capacitor equipment for improving power factor of resistance-welding machines

The Conco Engineering Works, Mendota, Ill., reduced the kva demand of this welder from 150 kva to 54.6 kva by installing series capacitors (partly shown at left). A serious wiring and power-factor problem within the factory was solved, and a bad light flicker in town was eliminated. The capacitors added only 14 per cent to the installed cost of the welder.

PROBLEM

Welding loads present a problem to both resistance-welding machine users and utility companies. First, because the power demand is high, and the power factor is low. Second, the load is single phase, causing unbalance on polyphase systems. Third, the duty is highly intermittent, causing light flicker.

SOLUTION

Capacitors can be used in series with the primary of the welding transformer to reduce kva demand from the line by improving power factor to approximately unity.

RESULTS

- **More welding machines can be used on an existing feeder.**
- **Heavier welds are possible on the feeders where capacitors have been installed.**
- **Reduced interference with other welders on the same feeder.**
- **Welding machines can be installed on feeders too small to supply the usual low-power-factor machines.**
- **Removal or lessening of the restrictions sometimes imposed by power companies.**
- **Reduction of light flicker.**
- **Smaller feeder and power-supply equipment are needed for new welders.**
- **The necessity of running a separate feeder for a welder can probably be avoided.**
- **Special, low-impedance, power-supply transformers are not necessary.**
- **Long-throat machines will have practically the same kilowatt demand as short-throat machines.**

Application information can be obtained by asking for Bulletin GET-1134. For specific recommendations call your G-E representative. He'll be glad to help you. General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

607-84-5780

AIRCO APPOINTS R. J. ROWEN MANAGER OF WHEELING DISTRICT

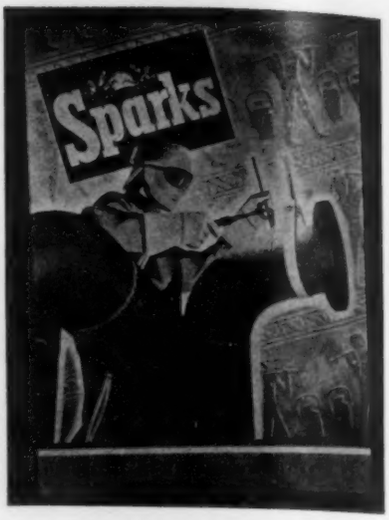
Air Reduction announces the appointment of R. J. Rowen as Manager of their Wheeling, W. Va., district. Mr. Rowen was one of the pioneers with Air Reduction, having started in 1916 as a shipping clerk in the distribution department at Philadelphia. Only seventeen days before war was declared in 1917 he was made a salesman covering eastern Pennsylvania.

Consequently, it wasn't long before he was "on the road" in khaki for Uncle Sam. On his return he resumed selling. His progress has been steady, having been appointed Assistant Sales Manager in 1923 and assistant to the General Sales Manager in New York in 1928. He returned to Wheeling two years ago as Assistant Manager.

"THE ROMANCE OF PIPING"

Nothing like this has ever been done before! Here is a study, a history, of the development of piping that begins with the first cave man to use a hollow log for piping water and takes you right up to the latest forward step in the widespread adoption of welded piping: its use in today's great shipbuilding program. The complete story is told . . . the piping from the Pyramids to the Outer Temple at the highwater line of the Nile . . . Solomon's acqueduct . . . stone and lead developments by the Carthagenians, Greeks, Romans . . . cast-iron piping's appearance in the fountains of Versailles in 1664 . . . the Gas Light Era . . . down to the significant improvements of what, by comparison, are just the "last few minutes" of man's use of this ancient and humble but honorable tool for transporting useful liquids, heat and waste.

No such history existed heretofore; it was necessary to do considerable preparatory research in large libraries, even to hire translators from German manuscripts. And it is all condensed into twenty minutes' intensely interesting

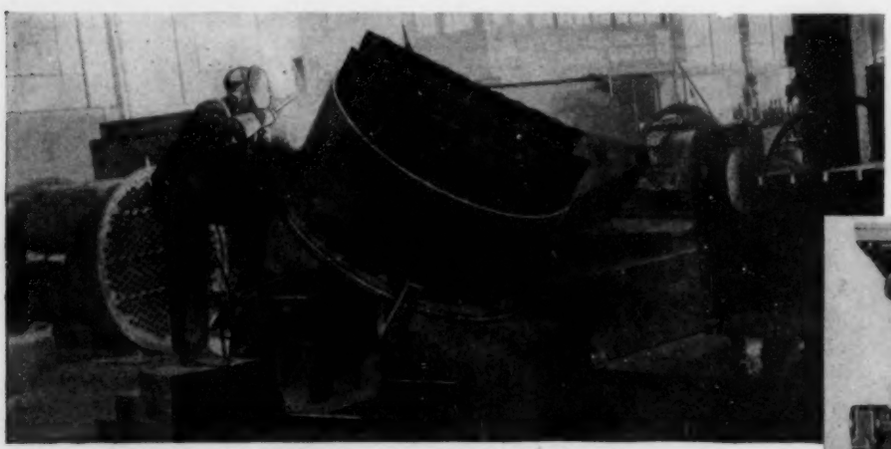


reading, beautifully illustrated with photographs and authentic drawings and presented in the current, spring 1943 issue of *Tube Turns Sparks*, a house magazine sent by this pioneer manufacturer of welding pipe fittings to 22,000 users and potential users throughout the country.

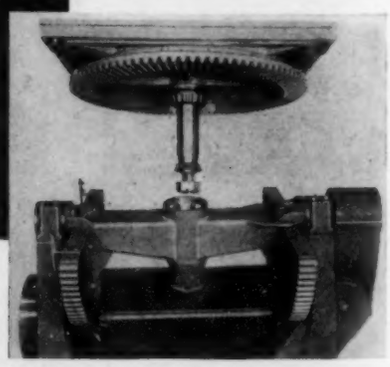
Copies may be obtained by writing to Tube Turns, Louisville, Ky.

MAINTENANCE OF FARM IMPLEMENTS AND EQUIPMENT

A new bulletin entitled, *Maintenance of Farm Implements by Arc Welding* has



SMOOTH ACCURATE ROTATION



. . . Another Ransome feature for faster and better welding

Indicative of the correct design and trouble-free construction of Ransome Welding Positioners is the use of two Timken Tapered Roller Bearings on the main spindle shaft.

With these bearings, the shaft is kept in perfect alignment . . . particularly important in maintaining a true circular path when using automatic welding heads on circular work.

Another advantage is that the grease-packed Timken Bearings require a minimum of attention.

Base frames, table tops, and table supporting yokes, on all Ransome Positioners, are of heavy welded construction. Hand-operated and motor-operated types . . . capacities up to 20 tons.

» *Write for literature*

Ransome WELDING POSITIONERS

INDUSTRIAL DIVISION • RANSOME MACHINERY COMPANY • DUNELLEN, NEW JERSEY

STARVING *in the midst of* PLENTY ?

To listen to most folks, you'd think America was starving. There is plenty to eat. The fighting men must be fed. So we, at home, get less coffee, sugar and butter. That may help some of us in industry appreciate why we can't get all the *materials* we would like.

In the matter of Welding Electrodes, for example, there never was a time when anything that approached today's production poured forth. That goes for PAGE, too, where tremendous volume of electrodes for welding Stainless Steel and Armor have swelled the total. *But fighting equipment comes first,* as PAGE still sees it.

So we continue to suggest you make it a daily *must* to see that the best welding practices are followed. See that welders have the most economical electrodes for the job, that no excess metal is deposited in the weld, that every bit of every electrode is used.

PAGE WELDING ELECTRODES

PAGE STEEL AND WIRE DIVISION

Monessen, Pa., Atlanta, Chicago, New York, Pittsburgh, San Francisco, Portland

AMERICAN CHAIN & CABLE COMPANY, Inc.

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ESSENTIAL PRODUCTS . . . TRU-LAY Aircraft, Automotive, and Industrial Controls, TRU-LOC Aircraft Terminals, AMERICAN CABLE Wire Rope, TRU-STOP Brakes, AMERICAN Chain, WEED Tire Chains, ACCO Malleable Castings, CAMPBELL Cutting Machines, FORD Hoists, Trolleys, HAZARD Wire Rope, Yacht Rigging, MANLEY Auto Service Equipment, OWEN Springs, PAGE Fence, Shaped Wire, Welding Wire, READING-PRATT & CADY Valves, READING Electric Steel Castings, WRIGHT Hoists, Cranes, Presses . . . *In Business for Your Safety*

just been released by The Lincoln Electric Company of Cleveland, Ohio.

The contents of the bulletin represent a digest of arc-welding techniques and procedures to be followed for obtaining the most efficient and economical results in keeping farm equipment in good repair.

A total of 47 photographs and illustrations are reproduced in the bulletin to support the text which covers such subjects as "Arc Weld Surfacing," "Hard Facing Worn Parts," "Building Up Worn Parts," "Repair of Broken Machinery" and "Building and Altering Equipment."

A copy of this useful, 10-page booklet will be sent on request. Ask for Bulletin 433.

TRUST FUND PLAN

R. H. Amberg, President of United Electronics Co. of 42 Spring St., Newark, N. J., announced that his company has adopted a trust fund plan under which all 250 employees will share profits of the war period at the end of the war.

Company officials said that this plan was one of the first to embrace all employees at a plant. It was also said that this was a "powerful incentive to offer war workers to increase war production efforts and to combat absenteeism."

The plan is designed to stop turnover of personnel during the war and to provide a "nest egg" for employees during the post-war period. The Company manufactures electronic transmitting tubes for war purposes. Eighty per cent of the employees are women.

The trust fund sets aside the equivalent of 9% of the total sum paid employees in 1942, which amounted to more than twice the net profit after taxes. This plan will be followed for the remaining war years, though the percentage set aside will vary in proportion to profits. Under internal revenue law it cannot exceed 15%.

To be eligible to share an employee must remain with the company until the end of the war, unless he is called into military service. The amount due each employee will vary in proportion to his salary.

The plan is to pay out the sum in the trust fund over a period of years, but the employee will be paid in a lump sum if he quits after the war, or if, in the opinion of the trust fund committee, circumstances warrant it. Illness or discharge would be causes.

In no case can any part of the fund revert to United. If an employee quits and forfeits his share it will be divided among those remaining. Each employee will be provided a record of his stake in the fund.

Amberg thinks the plan will help stop absenteeism because the employee will fear getting fired. "In my opinion it would stop all this floating around of labor if all plants adopted this plan," Amberg declared. He thought it would also work against inflation.

Bonuses also are paid employees and they get vacation pay, both of which practices will be continued under the trust plan. The trust fund will be invested in government bonds. It is administered by a committee consisting of Benjamin F. Steiger, company treasurer; Mrs. Oliver Thaler, personnel director and Francis L. Tolley, a representative of employees.

WELDING POSITIONERS CATALOGUE

A most interesting bulletin giving complete description, copiously illustrated, of the wide variety of the Lyon Welding Positioners is now available in the new bulletin No. 131. Copies may be obtained on request from the Lyon-Raymond Corp., Greene, N. Y.

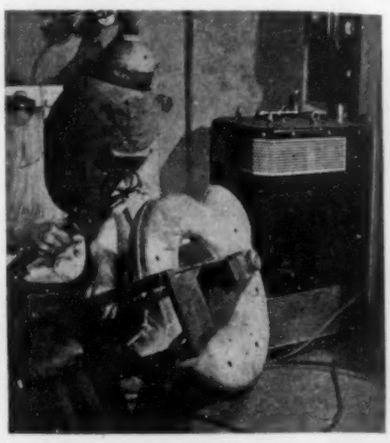
BULLETIN ON NEW REFRIGERATED WELDING ELECTRODE DEVELOPMENT

Announcing an entirely new development in refrigerated welding electrode design, a six-page, four-color Bulletin No. P-43 has just been released by Frostrode Products, 19003 John R St., Detroit. Completely described are the design, construction and operation of the "FROST-"POINT" permanent electrodes with replaceable finned "FROSTCAPS," also 'FROSTPOINT" adapter holders to convert any spot welder to the process. Color cuts show coolant circulation, improved installation practice and unique method of cap replacement with electric pliers.

Use of this development, it states, conserves 90% electrode copper, increases welding production, eliminates point dressing, permits more effective cooling and cuts electrode replacement costs.

ATOMIC-HYDROGEN ARC WELDING SPEEDS AIRPLANE EQUIPMENT

High-temperature atomic-hydrogen arc welding is speeding the fabrication of high-altitude airplane equipment, according to R. F. Wyer, welding application engineer of the General Electric Company. Among the principal items are oxygen containers, hollow propeller blades and superchargers.



Atomic-hydrogen Welding Being Used in Fabrication of a Stainless Steel Nozzle Box for an Airplane Turbo-supercharger in a General Electric War Plant

"When a fighter pilot bails out at 40,000 feet with an oxygen container strapped to his chest, that container must be extremely lightweight for him to carry, but strong enough to stand the 400 pounds pressure per square inch of the oxygen it encloses," Mr. Wyer explains. "Such containers can be made of thin steel sheets, provided the seams joining them are strong enough to resist the pressure. So far atomic-hydrogen arc welding is

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A Flux for every metal: Cast Iron Welding Flux No. 1; Brazing Flux No. 2; Braz-Cast Flux No. 4, for bronze-welding cast iron; "ABC" Aluminum Flux No. 8 for sheet Aluminum and all alloys of Aluminum; Stainless Steel Flux No. 9; Silver Solder Brazing Flux No. 10.

ANTI-BORAX COMPOUND COMPANY
Fort Wayne, Indiana

You'll do it better with

SHAWINIGAN CARBIDE

SHAWINIGAN PRODUCTS CORPORATION
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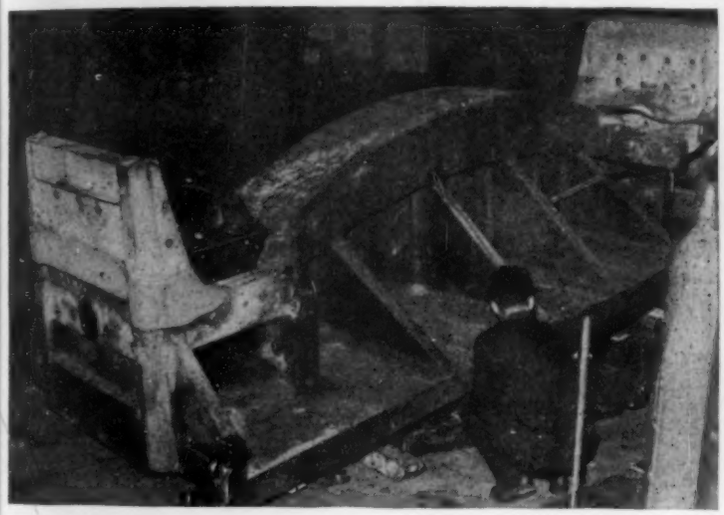
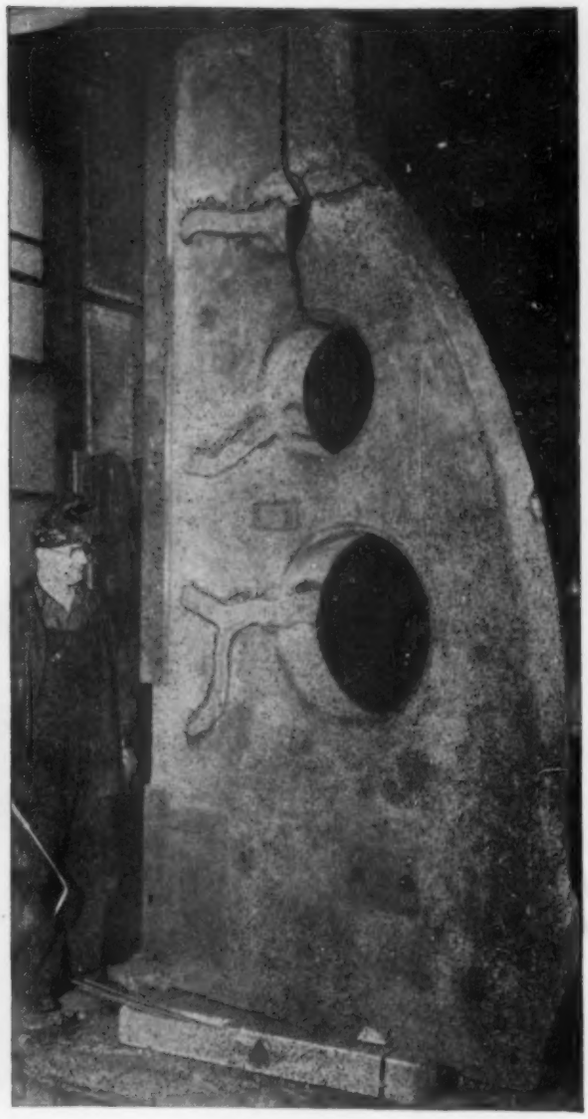
Credit quick BRONZE WELDING with two more outstanding repair jobs





(Left) A 14-ton ram—badly fractured—but put back into service in only 6 days . . . with 1750 lbs. of Tobin Bronze. (Right) A 2-ton section of a boring mill—cracked in four places . . . Anaconda "997" Low Fuming Rod made it as good as new—with only 39 man hours for chipping and welding.

Day by day, a lot of money is being saved in both time and vital equipment by repair welding with Anaconda Rods such as Tobin Bronze* and "997" Low Fuming. The availability of this fast, efficient method of repair gives war industries a potent aid in keeping up production. For information on welding with Tobin Bronze and 15 other Anaconda Rods, write us for Publication B-13. You'll find it especially useful at this time when prolonged equipment life is so important. 4305

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General Offices: Waterbury, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

*Reg. U. S. Pat. Off.

Anaconda Welding Rods

ANACONDA

generally conceded to be the most satisfactory process for joining the seams.

"Atomic-hydrogen arc welding has also been utilized to advantage in the joining of light-gage sections of stainless steel, always difficult to work, in the production of superchargers, which make high-altitude flying possible.

"Atomic equipment for this process is also responsible for corresponding savings in man-hours in the high-speed production of Bren gun magazines, axle housings and other war products. In numerous instances atomic-hydrogen arc welding is also restoring to service damaged precision tools which would otherwise be beyond repair."

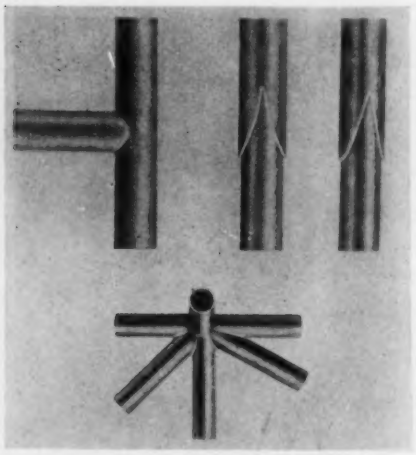
LOW TEMPERATURE WELDING FOR AIRCRAFT

An important mid-western aircraft company has just secured approval to use Castolin Eutectic Alloy No. 16 on several aircraft parts.

The procedure to be adopted is as follows:

1. Allow $^1/_{32}$ to $^1/_{16}$ in. split between the tubing. Use a small torch. Be sure the surface is clean. Apply Castolin Autochemic Flux No. 16 then preheat slightly 1 in. away on both sides of the seam until dull red is reached.

2. Use the torch horizontally to the tubing, heating only small sections of the circumference.



3. Now build up a jointing fillet at least $^1/_{16}$ in. thick and $^1/_8$ in. wide to join the two tubings. Reinforced fillets or beads of any desired thickness can be applied from $^1/_{32}$ to $^1/_4$ in. thick, in order to obtain the desired safety margin. The rod is kept in front of the torch. Allow a space of $^1/_4$ in. between flame cone and metal surface. Only a small section (for example $^1/_2$ x $^1/_2$ in.) is heated at one time to a dull red. Only 1300° F. is needed on the edges of the tubings where the Castolin Alloy should flow and bind. The Castolin Autochemic Flux No. 16 is a perfect temperature indicator; when it melts in front of the flame the welder can start melting his rod. No fusion of the steel takes place. Tensile strength on chrome-moly steel is as high as 117,000 psi.

4. When the weld is complete, keep torch circling for three seconds around tubing to avoid too rapid cooling.

SUSTAINING COMPANIES

Worthington Pump and Machinery Corporation, Harrison, N. J. New Worthington products for the war program include main propulsion steam engines for Liberty Ships and large anti-aircraft gun mounts; other products for the petroleum industry in production, transportation and refining—for refrigeration and air conditioning in every branch—for steam power, land and marine, including turbines, condensers, feedwater heaters and auxiliaries —feedwater heaters for railway locomotives—Diesel and gas engine units—air and gas compressors for all industrial uses—a comprehensive line of contractor equipment—and pumping equipment whose scope is the most extensive available.

The Buffalo Tank Corporation are steel plate fabricators with two plants, one at Dunellen, N. J., and the other in Buffalo, N. Y. They are engaged 100% in war work. This work includes the manu-

Castolin Eutectic*

LOW TEMPERATURE WELDING

NO RISK OF BURNING IN JOINING LIGHT TO HEAVY GAUGE

PROBLEM

To join the thin bronze mesh of these oil tank hose strainers to the thick brass frame without overheating and burning the mesh. With high temperature fusion welding such damage was prevalent. As a result vital metal and man-hours were needlessly wasted on a great number of the units produced.

SOLUTION

With Castolin Eutectic Low Temperature Welding Alloy No. 180 these strainers are being turned out in but a fraction of the time with no waste of vital metal through overheating damage. Castolin Eutectic Alloy No. 180 binds at 1290°F . . . *gives stronger, smoother, color matching joints requiring no after-machining.*

Only "Eutectic* Alloys" are the true Low Temperature Welding Alloys that are revolutionizing production welding, maintenance welding and salvaging in war plants throughout the nation. There are 42 specialized rods for every metal and every welding job. Developed and manufactured only by Eutectic Welding Alloys Company.

*Reg. U. S. Pat. Off.

New 36 page Welding Data Book E Write Today

EUTECTIC WELDING ALLOYS COMPANY

SOLE MANUFACTURER - CASTOLIN EUTECTIC WELDING ALLOYS

40 WORTH STREET, NEW YORK, N.Y

WESTERN UNION
LDG85MC (WA 903) GOVT LG
WUX WASHINGTON DC MAR 13, 1943 818P
EMPLOYEES OF SCIAKY CORPN
4912 W. 67TH ST CHGO
ARMY AIR FORCES PILOTS FLYING BELL AIRACOBRAS YOU HELPED TO MAKE SCORED 38 OUT OF 40 BOMB HITS IN ONE RAID ON JAP INSTALLATIONS DURING THE GUADALCANAL CAMPAIGN. IN THAT ATTACK TRACERS FROM ENEMY ANTI-AIRCRAFT GUNS "STOOD OUT LIKE SOLID STREAKS OF FLAME BUT THE AIRACOBRAS ROARING DOWN AT MORE THAN 400 MILES AN HOUR PRESENTED DIFFICULT TARGETS" THE REPORT TO THE WAR DEPARTMENT STATED. STRAFING THAT FOLLOWED THE BOMBING "WAS THE MOST BEAUTIFUL PART OF THE WHOLE SHOW" AIRACOBRA PILOTS WERE "ALL OVER ANTI-AIRCRAFT GUNS LIKE A SWARM OF HORNETS BLASTING AWAY WITH MACHINE GUNS AND CANNON. THE ENEMY GUNS WERE SILENCED IN SHORT ORDER" WORKERS IN HUNDREDS OF PLANTS PRODUCING PARTS ACCESSORIES SUB-ASSEMBLIES AND FINISHED AIRACOBRAS HELPED OUR PILOTS CRUSH THE JAPS IN THAT ATTACK. THE ARMY AIR FORCES ARE PROUD OF EVERY ONE OF YOU WHOSE SKILL AND WORKMANSHIP IN FACTORY OFFICE OR ENGINEERING LABORATORY HAD A PART IN PUTTING THOSE PLANES INTO ACTION
ECHOLS MAJOR GENERAL
RECEIVED
MAR 15 1943
SCIAKY BROS
THE QUICKEST, SURETY AND SAFEST WAY TO SEND MONEY IS BY TELEGRAPH OR CABLE
"PILOTS FLYING BELL AIRACOBRAS You Helped to Make SCORED 38 OUT OF 40 BOMB HITS"
The Army Air Force Praises SCIAKY Skill and Workmanship
(Western Union Telegram)
SCIAKY BROS. salute the gallant and intrepid Army Air Force Pilots . . . and their brilliant work in cleaning up the "Jap-rat" infested Guadalcanal. Sciaky Bros. employees pledge themselves to even greater War effort and to offering every possible assistance to our Armed Force.
SCIAKY
PROCESS ELECTRIC RESISTANCE WELDING
STORED ENERGY WITH PREHEATING
VARIABLE PRESSURE WITH PRECOMPRESSION
Sciaky Type PMCR-2516 Electric Resistance Welder, welding 70 spots per minute, on two sheets of aluminum alloy of .040" each. Welding capacity from two thicknesses of .016" in aluminum alloys up to and including .080".
SCIAKY BROS., 4915 W. 67th STREET • CHICAGO, ILL.

facture from steel plates (1/8 to 1 in.), of storage tanks, pressure tanks, breechings, steel pipe from 18 to 120 in. in diameter, processing tanks for chemical and synthetic rubber industries, miscellaneous equipment for manufacturing of 100-octane aviation fuel and other war equipment. They manufacture these various items as a subcontractor for the Army, Navy, Air Corps, Ordnance, Maritime Commission, Lend-Lease and Defense Plants.

Baldwin-Hill Co., Trenton, N. J., manufacturers of a complete line of high- and low-temperature insulating materials, formed from Baldwin-Hill black rockwool. B-H "Insidline," a growing specialty, requires considerable welding. It is an insulating lining fitted to the inner surface of pipes and lines which carry high pressures at high temperatures. The insulation is held by an alloy-steel retainer. Special design and welded construction hold the lining in position and allow for expansion, with a minimum of metal-to-metal contact.

Pollak Manufacturing Company, Arlington, N. J., designers and manufacturers of automotive, aeronautical and electrical devices. Has own tool design, engineering and development departments. Equipment for mass production includes batteries of automatic screw machines, and modern and diversified welding facilities. Plants occupy an area of 300,000 square feet. Now engaged 100% in war production.

OBITUARY

Alfred Seguine Kinsey, professor emeritus of shop practice at Stevens Institute of Technology, died on April 7th at his home, 74 Fairview Ave., Chatham, N. J., at the age of 72. He retired as head of the shop department at the institute in September, 1941, after fifty-five years of service.

Mr. Kinsey was born at Mendham, N. J., a son of Benjamin H. and Margaret S. Kinsey. He took a job with the institute in 1886 as a shop assistant. While thus employed he attended night classes at Cooper Union in New York.

In 1890 he became an assistant in the tests department, and during eighteen years there he worked on tests of boilers, pumping stations, electric plants and other mechanical equipment. For four years he was in the mechanical engineering department, going from that to become administration officer in charge of the department of buildings and grounds. In 1908 he was placed in charge of the department of shop practice, which he reorganized and expanded.

Professor Kinsey was active in the affairs of the AMERICAN WELDING SOCIETY in the early days having served on the Board of Directors and as Chairman of the Gas Welding Research Committee of the American Bureau of Welding. At that time Professor Kinsey was identified with the Air Reduction Sales Company as a Consulting Engineer.

Professor Kinsey leaves a widow, Antoinette; three children, Dr. Alfred C. Kinsey, professor of zoology at Indiana University, Mrs. D. E. Garrabrant of South Orange, and Robert B. Kinsey of Bloomfield, and five grandchildren.

METALLURGICAL PROBLEMS

Metallurgical Problems, by Allison Butts, A.B., B.S., Professor of Electrometallurgy, Lehigh University, Co-author of *Engineering Metallurgy*. Second edition. Published by McGraw-Hill Book Co., New York and London. Price $4.00. 446 pages. Book includes fundamental data used in metallurgical calculations. Many of the problem statements are made up from actual data secured from metallurgical plants.

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Made in a range of sizes—in portable and stationary models—for all shop and industrial service needs. Sight Feeds are listed for safety by UL and FM. Write for full information.
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Sales: Richmond, Ind. Factory: W. Alexandria, O.

Putting a New Face on it...

Now, with production pushed to capacity, the long, trouble-free performance of Monel is doubly important . . .

Rotary filters, dandy rolls and cylinder molds have tight-fitting, long-lasting covers—when covers are made of Monel wire cloth by expert craftsmen.

Seams are smooth, cannot fill up. And Monel covers are strong, have high resistance to wear and corrosion.

A widely used method of joining Monel covers is by silver brazing. When such joints are properly prepared their strength is about 50,000 p.s.i. in tension and 30,000 p.s.i. in sheer, at room temperature. Design calculations should be based on these values, using a safety factor of 5.

600°F. is the maximum temperature to which silver brazed joints can be subjected and still support an appreciable load. For, at that point, their tensile strength is only about 50% of normal.

Alloys whose melting points are below 1,200°F. are best for silver brazing high-nickel materials. Handy & Harman "Easy Flo" Brazing Alloy is recommended, as is "Handy Flux".

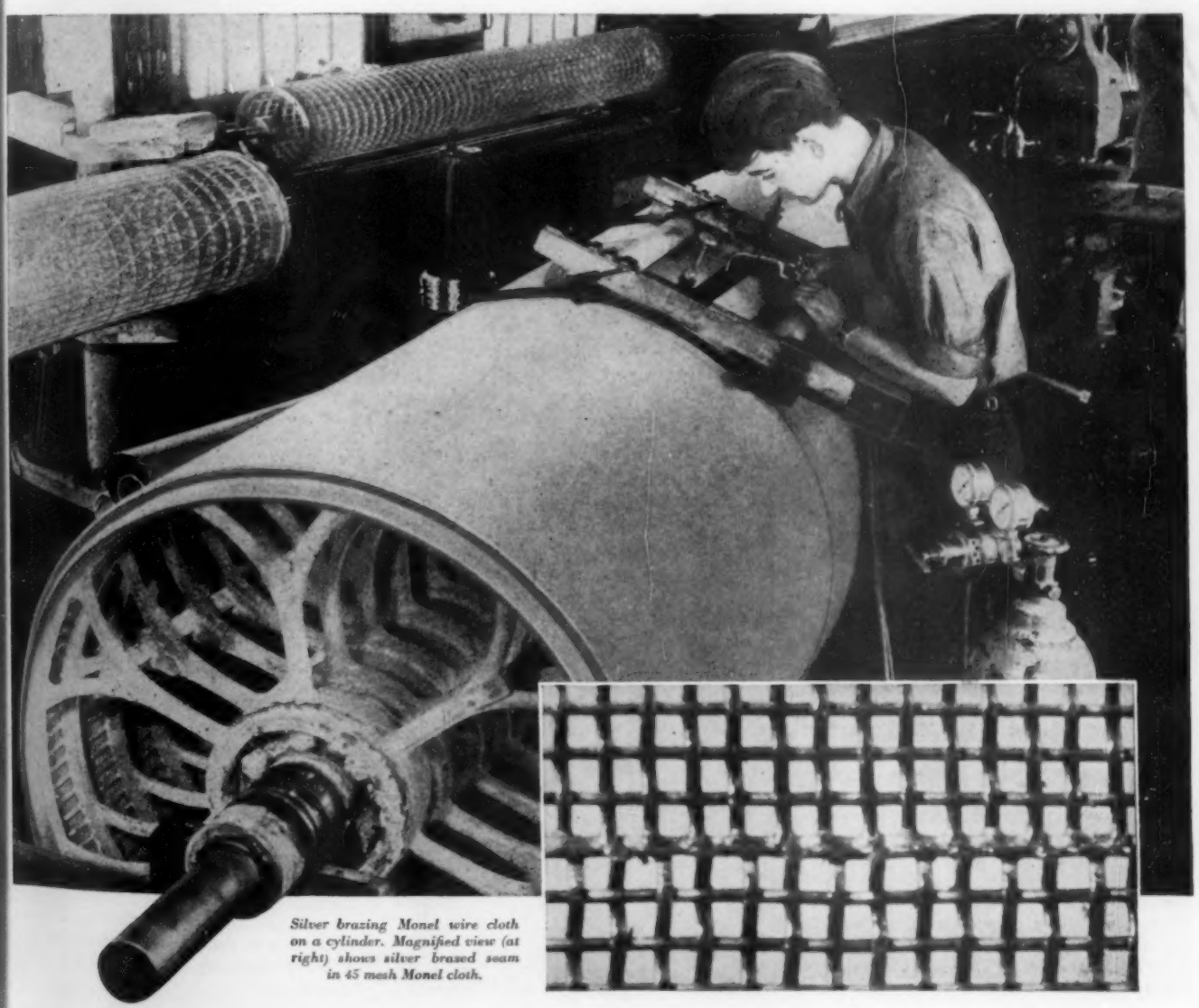
Before brazing, remove all dirt and foreign matter. Next, apply flux to prevent oxidation during heating, to dissolve harmful oxides and float them to the top of the braze puddle, and to assist in flowing out the brazing alloy.

Heat for silver brazing operations is generally supplied by a torch burning either oxygen and acetylene, or oxygen and city gas. A neutral or slightly reducing flame is used.

Parts must be thoroughly heated in order to flow out the brazing alloy.

Since the temperatures employed are well below those for annealing Monel, Nickel and Inconel, the softening effect of brazing is very slight.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street **New York, N. Y.**



Silver brazing Monel wire cloth on a cylinder. Magnified view (at right) shows silver brazed seam in 45 mesh Monel cloth.

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

NEW ELECTRODE

A new all-position a.-c. electrode for electrode welding, known as Murex Type A, has been developed by the Metal & Thermit Corporation, N. Y. With this new a.-c. electrode, overhead and vertical welds can be made without the use of a highly specialized welding technique, according to the manufacturer.

Murex Type A electrodes meet the requirements for Grade E-6011 electrodes, under A.W.S.-A.S.T.M. specification A-233-42T, for Grade III, Classes 1 and 2, under U. S. Navy Bureau of Ships specification 46E3, and for grades H1G, B1G and E2G, American Bureau of Shipping, the manufacturer states.

The new electrode is available in 3/32, 1/8, 5/32 and 3/16 in. sizes. Typical physical properties of the weld metal, as welded, include yield points of 52,000 to 61,000 psi. ultimate strength of 62,000 to 71,000 psi. and an elongation of 22 to 26% in 2 in.

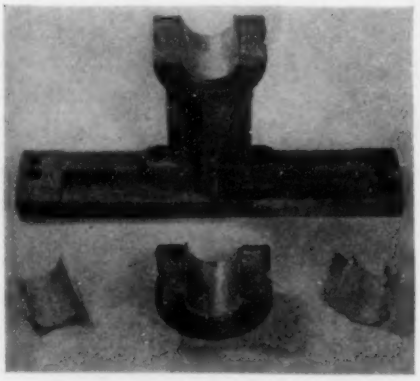
HARD-FACED BEARINGS

Hard alloy bearings, and bearing gudgeons hard-face with a similar alloy, have outworn bronze bearings by a service life of over 12 to 1 in a corn steamer conveyor operated by the Kellogg Co., Battle Creek, Mich. The conditions under which the bearings operate are somewhat difficult, because the conveyors carry corn grits or cracked corn while it is being cooked, and, to steam the corn while it is moving in the conveyor, steam is injected into the system.

The conveyor shafting of the corn-grit steamer, made of S.A.E. 1020 steel, formerly operated in bronze bearings. Because no lubrication is possible, lest the corn be contaminated, and because some of the paste from the steamed corn gets into the bearings, both wear and corrosion developed so rapidly that the bronze bearings and gudgeons required replacement every 4 to 6 months.

The first alloy bearing material was installed in the early part of 1936. It consisted of two inserted half-bearings of Stellite No. 6 rolled alloy as the hanger bearing surface, and a welded-on hard-facing deposit of the same alloy covering the shaft wearing surface. The shaft deposit was made by the oxyacetylene process and ground to dimensions.

After about 3 1/2 years of satisfactory service the alloy parts were removed for inspection. They showed so little wear that they were reinstalled and have been in service ever since. The users state that because of the excellent corrosion resistance of the alloy the color and taste of the finished corn flakes are not affected.



Top, a Conveyor Bearing Hanger Showing a Half-Bearing of Stellite No. 6 Rolled Alloy in Place. Bottom Center, the Other Half of the Bearing. Both of These Are Shown After 3 1/2 Years of Continuous Service. New Alloy Half-Bearings Are Shown at the Bottom Left and Right

---

TURBAN

A new protective turban for women welders styled by John Frederics is announced by the American Optical Company, Southbridge, Mass. The new hat is practical, comfortable to wear—with or without helmet—provides protection against flying sparks, and holds the hair snugly in place. Its features:

Comfortable to wear: Designed for comfort underneath a welding helmet—without alterations.

Leather or cassimere: Offered in lightweight gray or brown leather—chrome tanned; and also in pin-striped dark gray cassimere—lightweight, fire-resisting, cool.

Easily cleaned: One-piece construction, assembled by snaps only—can be easily disassembled for cleaning.

Long wearing: The chrome-tanned protective turban has no stitching whatever. The only stitching on the cassimere turban is on the hemmed edges.

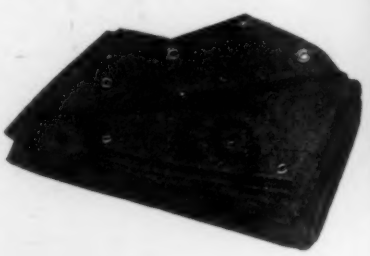
One size: Due to practical design, one size fits every type of head closely enough for all practical purposes.

Protects hair and ears: Holds hair snugly in place, protects hair, ears and back of neck from flying sparks.

Exclusive design: Styled by John Frederics—one of America's foremost millinery creators—guided by a practical welder.

WELDING CURTAINS

The IPCO Welding Curtain is designed to confine the welding operation to a given area and protect other workers and passers-by from the harmful direct and reflected rays given off by the welding operation. Also serves as a protecting shield against flying chips and scale when cleaning is being performed.



Constructed of a special flame-proof and water-proof canvas, or asbestos. Double row stitching is used on all seams; substantial hem on all four sides; corners reinforced. The workmanship is thorough.

For further information write to Industrial Products Co., 2820 N. Fourth St., Philadelphia, Pa.

WELDING EQUIPMENT CONVERTED FOR INCANDESCENT BRAZING

Among the special-purpose machines converted from peace to war production at General Electric's Schenectady Works are some spot welders and line welding machines previously used for refrigerator unit manufacture and now used for incandescent brazing.

The spot welders were adapted for incandescent brazing by the following three changes:

1. A switch was installed in the controller box to provide the continuous flow of power necessary without the use of the drive motor.

(ACME)

USE RACO COMPOSITE TYPE D ELECTRODES

Have you looked into the possibilities of using *Raco Type D* Electrodes instead of shielded arc electrodes?

There are many jobs being done today ... or being held up for lack of shielded arc electrodes ... which could be satisfactorily handled by the use of *Raco Type D* white coated electrodes.

If you are welding mild steel ... for storage tanks, range boilers or products of a similar nature ... or working with galvanized material ... or producing pans or boxes of lighter gauge sheet metal ... take time to look into the availability of *Raco Type D*. The only type electrode readily available that will give results most nearly comparable to Shielded Arc type electrodes.

Many millions of pounds of *Raco Type D* electrodes have been used for automatic and manual welding for the past ten years by the largest automobile plants where high speed is of primary importance.

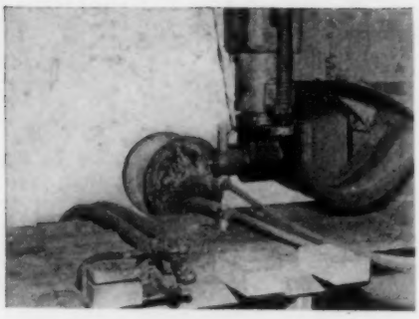
We can make prompt deliveries of Raco Type D Electrodes. Samples of standard size electrodes will be promptly furnished on request.

RACO

The REID-AVERY COMPANY

DUNDALK, BALTIMORE, MARYLAND

Makers of Raco Type HD Shielded Arc Electrodes for Stainless Steel, Mild Steel. Raco Type M and Type D Light Coated Electrodes for Manual and Automatic Work. Samples and Literature on request.



2. The standard spot-welding electrodes were replaced by dummy copper electrodes drilled and tapped at one end where copper blocks are attached for the water-cooling supply and return.

3. To these copper blocks were attached large water-cooled leads (183,000 circular mils) and brazing tongs.

The leads were made 10 ft. in length so that the working area would not be limited to the table. Plier-type brazing tongs can be connected to these leads and brazing operations performed within a 10-ft. radius of the table. This permits other jobs to be set up while working on one.

The transformers were removed from the line-welding machines, providing immediately an adequate supply of that equipment for permanent installation elsewhere as needed. These spot- and line-welding transformers have a range of from 75 to 250 kva. in capacity operating on 550 volts a.-c. primary and 4 to 14 volts secondary, having a range of from 0 to 16 points of heat. This extra range in secondary voltage permitted the use of longer leads than would be possible with the 10- and 20-kva. brazing transformers ordinarily used, and were ideal for that reason. They are water-cooled, minimizing the possibility of burnouts from overloading.

ALKALI CLEANER AND DEOXIDIZER

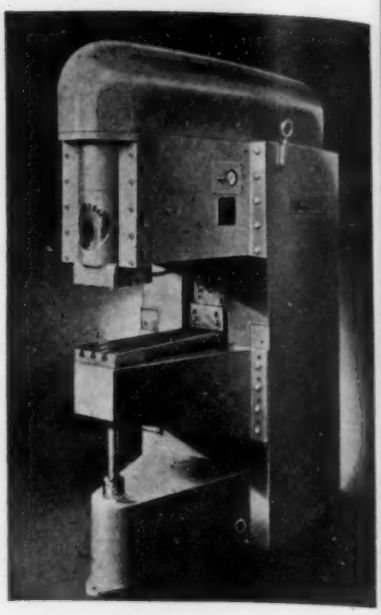
Nielco Lab. No. 1921 is a free-flowing powder, readily soluble in warm water, requiring no special type of containers for shipping, and produced to meet a specific demand for a combination cleaner and deoxidizer that would be safe to use on aluminum and which would not tarnish copper.

There has long been a demand for a product that would clean as well as remove the oxide from Alcad and Dural Aluminum prior to spot welding. Nielco Lab. No. 1921 accomplishes this without, in any way, changing the surface of the metal.

For further information write to Nielco Laboratories, 19720 Florence Road, Detroit, Mich.

STANDARD PRESS WELDERS

Standardized design combined with the maximum simplicity in operation and flexibility as to application are characteristics of a complete line of "press" or "projection" type resistance welders announced by Progressive Welder Company, E. Outer Drive, Detroit.



The line of standard machines, comprises four basic types: light duty, medium duty, heavy and extra-heavy duty. Each type is in turn available in from 4 to 6 kva. capacities, and a variety of throat depths.

Each model is available in either air-operated or motor-driven style, while extra-heavy models are also produced

National

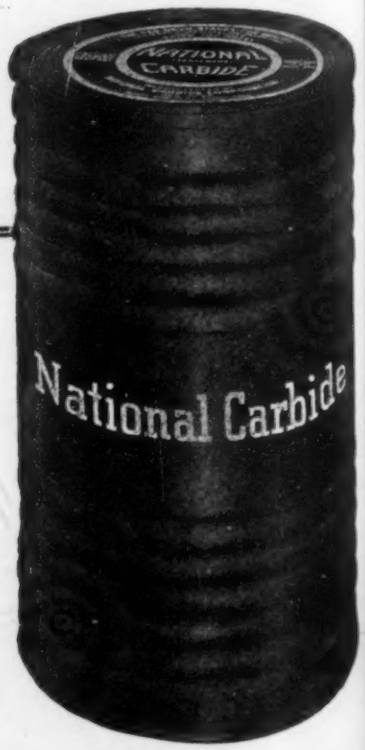
Carbide

IN THE RED DRUM

EFFICIENT

ECONOMICAL

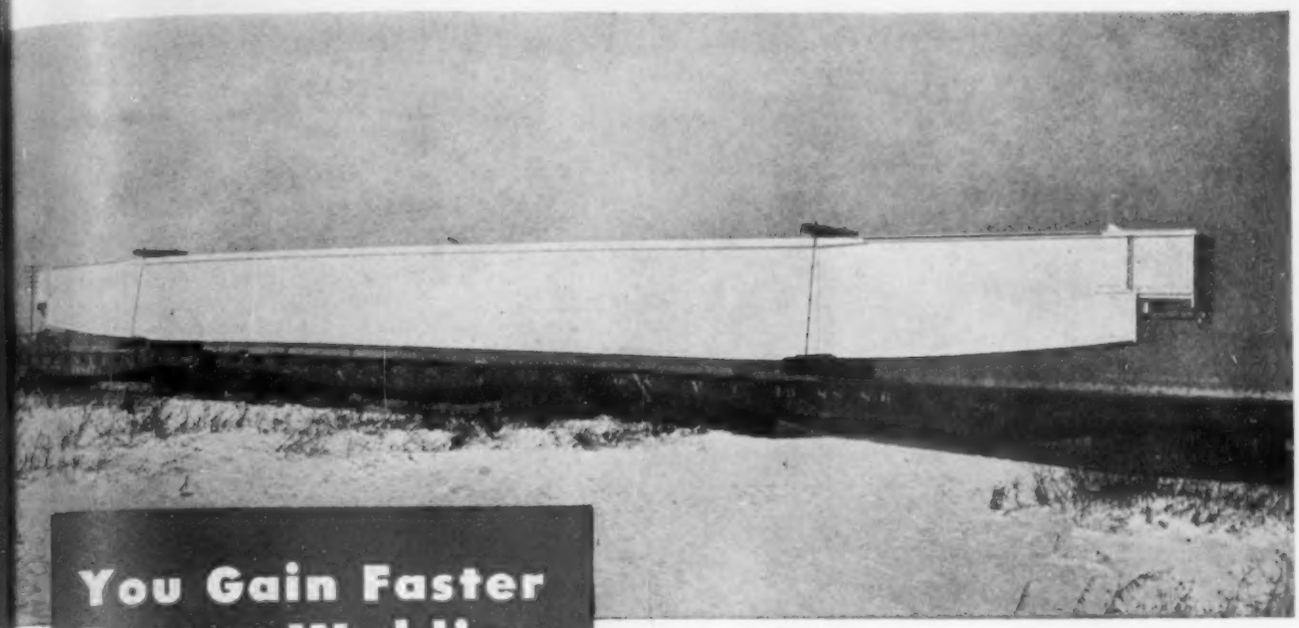
DEPENDABLE



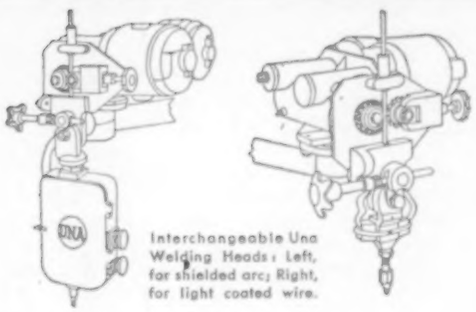
FOR WELDING and CUTTING

Use National Carbide in the Red Drum

60 E. 42nd St. NATIONAL CARBIDE CORPORATION New York, N. Y.



You Gain Faster Better Welding on more kinds of Work -- with UNAMATIC



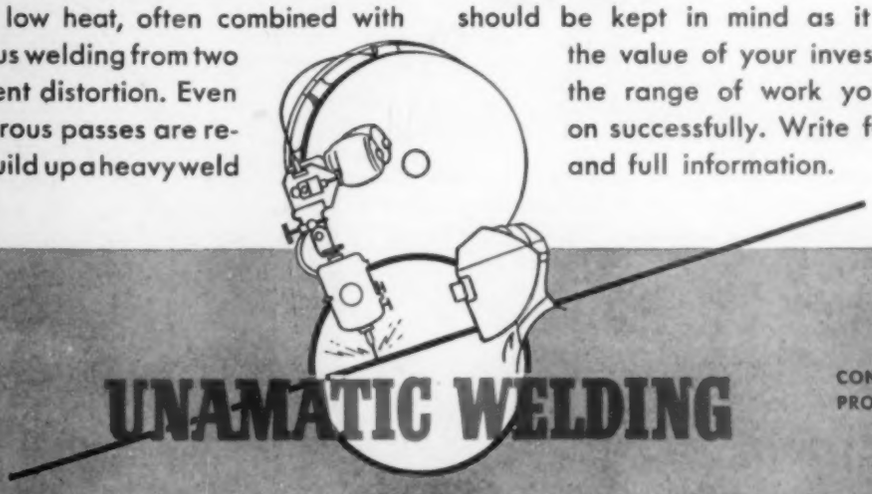
Interchangeable Una Welding Heads: Left, for shielded arc; Right, for light coated wire.

WELDING jobs like the 120-foot, 30-ton girder shown above emphasize the fact that Unamatic Welding is not merely faster but better. In many cases the 200% to 300% greater lineal speed, as compared with manual operation, is often the factor that makes a successful welding job possible.

In girder work, distortion due to heat conduction is often a real problem. Unamatic fast travel and low heat, often combined with simultaneous welding from two sides, prevent distortion. Even when numerous passes are required to build up a heavy weld there is a large net saving of time and cost.

Unamatic shielded arc welding equipment is adaptable for use with light coated wire. A simple change in the head, easily made in your own shop with elements we supply at nominal cost, enables you to convert from shielded arc to light coated at will.

When changing from manual to automatic welding this versatility of Una equipment should be kept in mind as it increases the value of your investment and the range of work you can bid on successfully. Write for catalog and full information.



CONTROLLED QUALITY

UNAMATIC WELDING

CONTINUOUS PRODUCTION

UNA WELDING INC. • 1615 COLLAMER AVE. • CLEVELAND, OHIO

with hydraulic operation. Each capacity range has a single basic frame designed to accommodate the heaviest duty model in that particular range, thus permitting ready conversion to higher or lower capacities within the duty range when required.

All models are fitted with universal T-slot platens for ready mounting of fixtures and dies. Knees of machines are vertically adjustable to permit setting for various throat openings desired for different jobs.

Again, all models are fitted with double cooling water manifolds in the base of the machine. These are provided with a series of outlets to permit connection of up to six die-cooling circuits to suit individual requirements. Platens are also water-cooled.

NEW LIGHTWEIGHT THYRATRON TUBE

Designed for applications where weight and space must be considered, a new thyratron tube with both a control and a shield grid for control applications, has been announced by the tube division of the General Electric Electronics Dept., at Schenectady, N. Y. Designated as the GL-502, the new tube is a little over $2^1/_2$ in. long, weighs about 2 oz., is inert-gas-filled and of all-metal construction. Applications for the new tube will be found in industrial welding and any general control equipment.

"The control characteristic is practically independent of ambient temperature over a wide range," according to O. W. Pike, G-E engineer. "Since the grid current is low enough to permit the use of a high resistance in the grid circuit, the new thyratron has high sensitivity characteristics. The grid-anode capacitance is low enough so that the new tube is relatively unaffected by line-voltage surges. It has a maximum peak inverse anode voltage rating of 1300 volts, instantaneous current rating of 500 milliamperes and an average current rating of 100 milliamperes. The cathode is quick heating and is rated at 6.3 volts, 0.6 ampere."

CAPSULES TO RELIEVE CONGESTED AREA IN TOKYO AND BERLIN

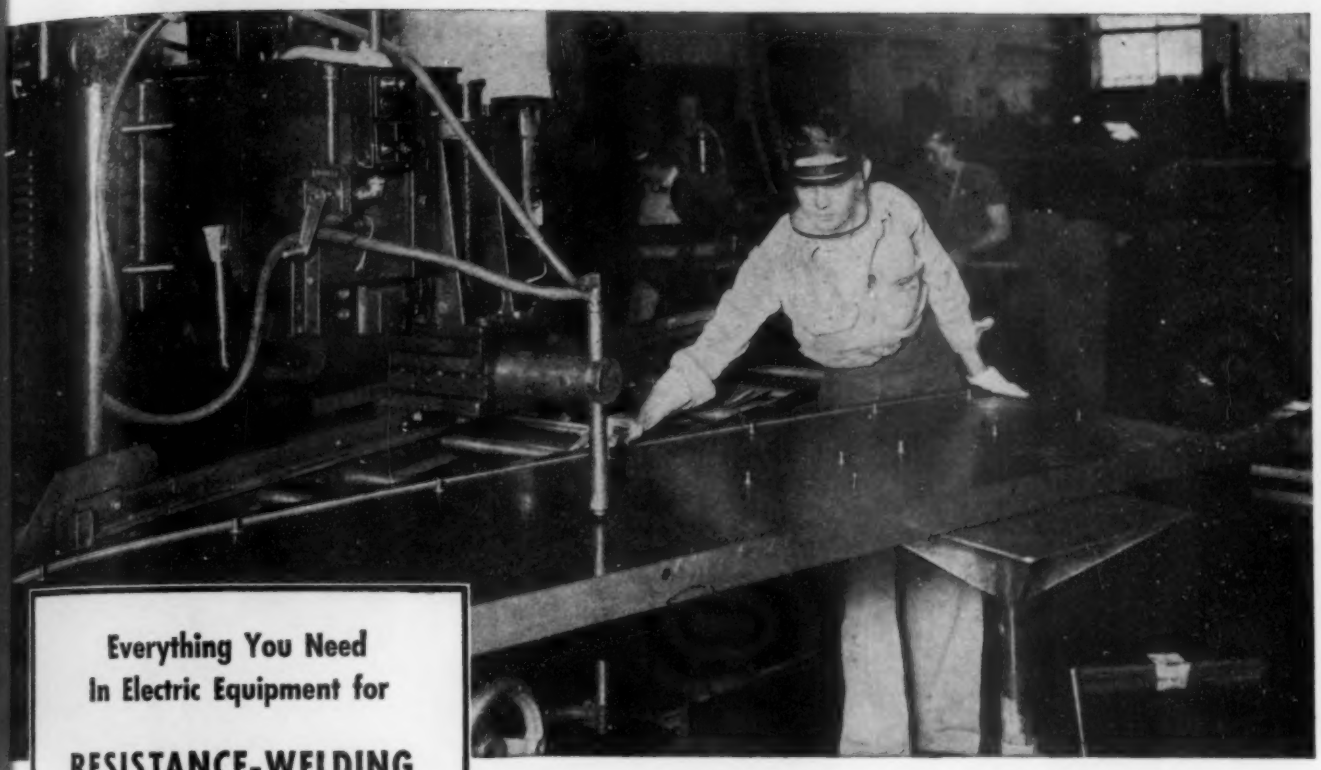
In forging there is not always sufficient material to meet the requirements or size and in order to salvage all of the material and the cost of labor involved in forming, these openings are built up to size by electric arc welding. The electrode which is used is known as "Shield-Arc 100," and the physical properties of this material are equal to that of the shell. After the shell is stress relieved this deposited metal has been tested and proved to have tensile strength to 115,000 psi.

Courtesy The Lincoln Electric Co., Cleveland, O.

There has been a tremendous saving on the material alone. These could not be salvaged. The cost of material that would have to be scrapped would amount to approximately $40 for each shell and

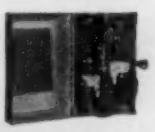
You Weld Fast!
AT LOWEST COST
● Your welds are stronger and better when you use a Miller AC Welder and your costs are lowest, because: You save time and labor on the job — speeding production. You save on electrode and power costs — on installation and maintenance, too.
Miller AC Welders
Made in ten models for every shop and industrial need.
Prompt delivery now. Write for full information.
MILLER ELECTRIC MANUFACTURING CO.
Sales: Richmond, Indiana • Factory: Appleton, Wisconsin

MILLER AC MEANS STRONGER, BETTER, LOWER-COST WELDS

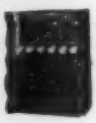


Everything You Need In Electric Equipment for

RESISTANCE-WELDING MACHINES



Electronic controls for spot and seam welders



Electronic weld and sequence timers

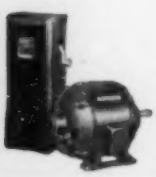
Weld-recorders—to record electrical input of EVERY weld

Electron tubes for all purposes

Cables and instruments

Air circuit breakers and welding transformers

Capacitors for power-factor improvement



Motors and control

How Spot-welding

SAVED 6 OPERATIONS

in Mounting These Studs

Today—

Insert a stud in the electrode and press the foot-switch. Before your foot returns to the floor, the weld is completed—strong, tough, *fast*. Stud and panel become *one piece* in *one operation*. Yesterday, before spot-welding took over, each stud took *seven operations*.

The Old Way—

Drill a hole, tap it, countersink it, screw in the stud, peen it (so it won't turn), grind off the rough surface, fill the stud head. *Seven* long steps. With 7 tools. But you can *spot-weld* a stud to that panel in the wink of an eye.

Resistance welding with precise electronic control is speeding the construction of light-metal and stainless-steel aircraft. Replaces soldering operations, too, saving tin and time. Joins like or unlike metals or alloys. Gives dependable, consistent results.

It makes gas-tight seams. Saves materials. Simplifies design problems. Relieves the shortage of skilled operators. Resistance welding is ideal for high-production operations on heavy or light work, portable or fixed, with men or women operators.

Whatever your application, be sure to specify G-E *electronic* control and electric accessories with your resistance-welding machine. For further information, contact any G-E office, your resistance-welding machine manufacturer or agent, or write Electronic Control Section, General Electric, Schenectady, N. Y.

Speed Production Electronically

GENERAL ELECTRIC

in addition to that there would be the labor cost involved.

ALL-WELDED MARINE SIGNALLING SEARCHLIGHT

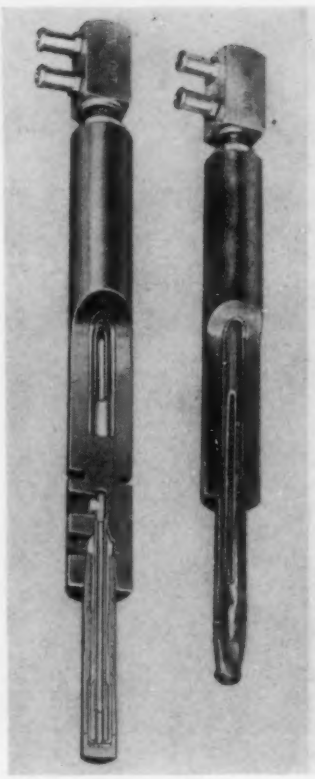
A 12-in. signalling searchlight with an all-welded construction designed especially to withstand shipboard vibrations and sudden shock has been announced by the Lighting Division of the General Electric Company. This searchlight, which supersedes previous designs, is made of bonderized steel and has a durable Marine gray finish over rust-resistant zinc chromate primer. It is intended for use on cargo vessels and transport ships.

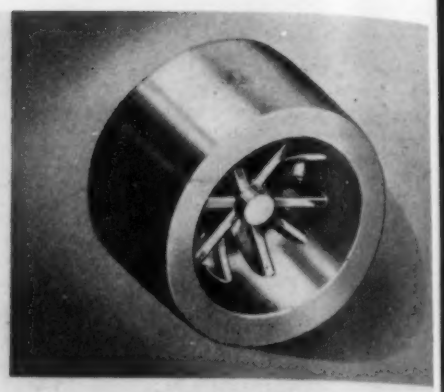
The supporting trunnion arms are heavy steel tubing, and are welded to other parts of the mounting assembly to form a one-piece construction which eliminates the danger of loosened joints due to rough weather and other adverse conditions. All handles are of molded plastic for easy handling in extreme temperatures.

ELECTRODES DESIGNED FOR REFRIGERATED WELDING

An entirely new development in resistance welding electrode design which, for the first time, makes possible the full utilization of refrigerated welding has been announced by Frostrode Products, 19003 John R St., Detroit, originators of refrigeration for resistance welding.

Aircraft manufacturers who have adopted the new "Frostpoint" as an integral part of the "Frostrode" electrode refrigerating process have already reported increases from 600 to 1000% over refrigeration of conventional electrodes in the number of spot welds which can be made before the tips require "dressing."





(Left) The Complete New "Frostpoint" Electrode with Adapter Fitting Into a Standard Electrode Holder. At Right, the Same Holder with Conventional Electrode. "Frostpoint" Electrodes Provide Positive Control of Refrigerated Coolant Circulation. Electrode Holder and Arms of Welder Remain Water Cooled. Permanent Assembly Avoids Possibility of Human Error in Locating Coolant Tube as in Electrode at Right

(Upper Right) The New "Frostcap," Claimed to Eliminate 90% of Copper Requirements for Spot-Welding Electrodes. Also Eliminates Hand or Machine Dressing of Points. Note Internal Fins Adding Strength and Cooling

(Lower Right) Refrigeration Makes it Possible to Use a Low-Temperature Solder Seal for the Cap. Caps Are Replaced with a Pair of "Electric" Pliers Like These

A 90% saving in the copper normally required for resistance welding electrodes is forecast by the fact that the only part that needs replacing in the new "Frostpoint" is the "Frostcap," a quick-replaceable tip on the end of the welding electrode.

Principal other features of the new "Frostpoint" are:

1. Machine and hand dressing of points is completely eliminated. If a "Frostcap" does mushroom, it is removed and replaced by another in about one minute's time. The life of a "Frostcap" without any dressing except polishing is estimated to be about equal to that of a conventional electrode redressed until no longer usable.

2. The cost of recapping a "Frostpoint" is only a few cents as against the usual cost of a complete new conventional electrode.

3. While "Frostcaps" can be quickly removed and replaced without disturbing the body of the "Frostpoint" in any way, the electrode is positively sealed against leakage. This result is obtained by the self-sealing method of assembly.

4. Greater cooling area obtained by internal integral finning of the "Frostcap" insures maximum heat dissipation to the coolant. The use of integral fins in the "Frostcap" provides inherent structural strength which permits a decrease in wall thickness of the entire cap and at the same time increases heat dissipation to the coolant.

ELECTROLOY ALLOYS for RESISTANCE WELDING ELECTRODES and DIES

Spot
Seam
Butt
Flash
Projection

ELECTROLOY ALLOYS were developed specifically for the resistance welding industry. ELECTROLOY ALLOYS cover the full range of physical properties necessary to the manufacturers and users of resistance welding equipment.

Our engineers will be glad to make recommendations for your special electrodes. Submit samples or specifications.

Catalog and prices available on request.

THE ELECTROLOY COMPANY, Inc. 1600 Seaview Avenue, BRIDGEPORT, Connecticut

"In Our Stepped-Up Program the Process of WELDING is Highly Important"

Lt. General Somervell

Amplifying his comments, Lt. General Somervell continued: "Welding has helped us obtain better war products in less time... introduced speed and safety in a considerable part of our rolling equipment. New welding processes are still being explored and developed..."

Yes—in war, the art of welding is being vastly expanded; it will serve to build a better future, when peace comes.

FOUR SIZES...SIX TYPES

Welding Range... 20-300 Amps.

In hundreds of war plants, factories, repair shops, and maintenance divisions, Emerson-Electric Portable A. C. Arc Welders are stepping up production and effecting "on-the-spot" repairs. ..Each welder is built to the same high quality standards, for long service, that have characterized Emerson-Electric products for the past 53 years. Approved by Underwriters' Laboratories. *Available on priority ratings.* Write for prices, specifications, and performance data.

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ST. LOUIS... *Branches:* New York • Chicago • Detroit • Los Angeles • Davenport

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Emerson-Electric is now engaged 100% in the production of equipment for War or War Plant Use. In addition to regular products are Power Operated Airplane Gun Turrets, Shell Parts and Electric Aircraft Motors.

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Conley, Alvin D. (C), 166 Harvard St., Wollaston, Mass.
Crabtree, Charles (C), General Elec. Co., 62 Tremont St., Everett, Mass.
Duffy, George F. (B), 128 Walnut St., Dorchester, Mass.
Ferris, Harry B. (D), 688 Tremont St., Boston, Mass.
Frankel, Morey G. (C), 185 Harvard St., Dorchester, Mass.
Hayward, Richard W., (B), 78 Waldeck St., Dorchester, Mass.
Kiley, Maurice F. (B), 50 Raddins Grove Ave., Lynn, Mass.
Kirby, John T. (D), 650 Saratoga St., E. Boston, Mass.
Kozlosky, Chester V. (D), 14 Bates St., Lynn, Mass.
Lenihan, John J. (D), 790 Western Ave., Boston, Mass.
Libby, Henry T. (D), 125 Heath St., Somerville, Mass.
Merigo, Margaret M. (D), 44 Marshall St., Somerville, Mass.
McElroy, John H., Jr. (B), 30 Arch St., Malden, Mass.
Paterson, John (D), 2 Clinton St., Cambridge, Mass.
Pires, Edmund (D), 337 So. Orchard St., New Bedford, Mass.
Radzik, Gene (D), 14 Rawson St., Dorchester, Mass.
Reilly, Joseph F. T. (D), 43 Downing Rd., Lexington, Mass.
Reynolds, John S. (D), 96 Washington St., Charlestown, Mass.
Saulnier, Ralph J. (D), 23 Brownville Ave., Ipswich, Mass.
Sederquist, Wilfred J. (D), 68 Floral Ave., Malden, Mass.
Thompson, Joseph A. (D), 32 Newton St., Everett, Mass.
Williams, Frank P. (D), 16 Connolly St., Roxbury, Mass.
Wilson, Albert O., Jr. (C), A. O. Wilson Struc. Co., 40 Smith Pl., Cambridge, Mass.

CANADA

Dell, Sidney A. (B), 94 Malakoff St., St. Thomas, Ont., Canada.
Lawrence, W. B. (B), John Englis Co., 14 Strachan Ave., Toronto, Canada.
Muir, G. (C), St. Maurice Chemicals Ltd., St. Mathieu Rd., Lac a la Tortue, Que., Canada.

CANTON

Tschudy, Donald B. (B), 1606—25th St., N.W., Canton, Ohio.
Yonally, Wm. H. (B), 510 Lincoln Ave., Cadiz, Ohio.

CHICAGO

Chapman, Wm. H. (B), Bendix Home Appliances, Inc., 3300 W. Sample St., So. Bend, Ind.
Gallaher, J. A. (B), Haynes Stellite Co., 230 N. Michigan, Chicago, Ill.
Hunt, Victor (B), 2452 N. Newcastle Ave., Chicago, Ill.
Jacobsen, Ralph O. (C), 4939 W. Congress St., Chicago, Ill.

CINCINNATI

Millard, A. J. (C), 30 Sherry Rd., Wyoming, Ohio.

CLEVELAND

Adams, John, Jr. (C), 2013 E. 44th St., Ashtabula, Ohio.
Allison, Clifford E. (C), 7723 Decker Ave., Cleveland, Ohio.
Connelly, E. C. (C), 1850 Front St., Cuyahoga Falls, Ohio.
Davis, Le Roy S. B. (C), 19040 Newton Ave., Euclid, Ohio.
Gardner, E. Boyd (B), 1331 Hillcrest Dr., Cuyahoga Falls, Ohio.
Noleen, Howard W. (C), % Lewis Welding & Engrg. Corp., Bedford, Ohio.
Pearse, Wilford A., Jr. (C), % Lewis Welding & Eng. Corp., Bedford, Ohio.
Ranney, R. B., Jr. (C), Lewis Welding & Eng. Corp., 1 Interstate St., Bedford, Ohio.
Rowlinson, Oscar C. (B), 708 No. Sandusky Ave., Bucyrus, Ohio.
Stein, R. Edward (C), 18801 Rivercliff Dr., Fairview Village, Ohio.
Vacca, Don A. (C), Advance Welding & Engrg. Co., 4400 Perkins Ave., Cleveland, Ohio.

COLUMBUS

Davis, W. W. (D), 3257 Leap Rd., Hilliards, Ohio.
Gilbert, Yowland (F), 2422 Indianola Ave., Columbus, Ohio.
Sharer, R. P. (C), 3007 N. High St., Columbus, Ohio.
Sullivan, F. E. (D), 2119 Minnesota Ave., Columbus, Ohio.

DETROIT

Bain, George (B), 2314 Adams Blvd., Saginaw, Mich.
Lex, Joseph R. (B), 35959—13 Mile Rd., Rt. 4, Farmington, Mich.
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Minard, Mark W. (C), 535 Annin Ave., Highland Park, Mich.
Rice, Emery F. (B), 2518 Forest Hill, Flint, Mich.
Rich, Roscoe R. (B), 1374 De Camp St., Flint, Mich.
Smith, Adam T. (B), 819 Bloor Ave., Flint, Mich.
Strahler, Chas. (C), Weldit Acetylene Co., 638 Bagley Ave., Detroit, Mich.
Webb, Shannon A. (C), 1129 Merrick Ave., Detroit, Mich.
Werner, Paul W. (C), 15504 Englewood, Allen Park, Mich.

HAWAII

Staples, F. Richard (C), Elks Club, Honolulu, T. H.

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Morgan, Wm. G. (B), 152 Noble St., Greenwood, Ind.

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Stieg, Bernard O. (B), 61 N. Main St., Clintonville, Wisc.

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Kirk, Edward M. (C), 2633 Caspian Ave., Long Beach, Calif.
Nelson, Wm. F. (C), 823 W. 4th St., Long Beach, Calif.
Tivy, George S. (C), 1406 S. Grand Ave., Los Angeles, Calif.
Tucker, Frank (D), Victor Equip. Co., 3821 Santa Fe Ave., Los Angeles, Calif.

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Siegel, Julius H. (C), 5150 Edmondson Ave., Baltimore, Md.

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Del Bene, Leon, (D), 1002 River St., Ridgefield, N. J.
Farb, Julius (C), Pan American Iron Wks., 447–53 E. 120th St., New York, N. Y.
Guthrie, K. O. (C), 21 Guion St., Pleasantville, N. Y.
Kazlauskas, A. C. (D), 57–51 64th St., Maspeth, L. I., N. Y.
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Krol, Joseph A. (D), 30 E. 34th St., Bayonne, N. J.
Leisenheimer, George (B), G. Leisenheimer Co., 984 Grand St., Brooklyn, N. Y.
McLaughlin, Peter (D), 776 Hudson Blvd., Bayonne, N. J.
Norman, C. W. (C), American Bureau of Shipping, 47 Beaver St., New York, N. Y.
Sabbatino, Frank (D), 200–20 Hollis Ave., Hollis, N. Y.
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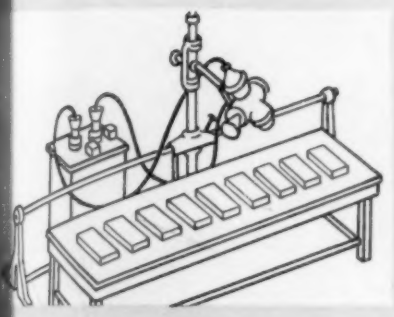
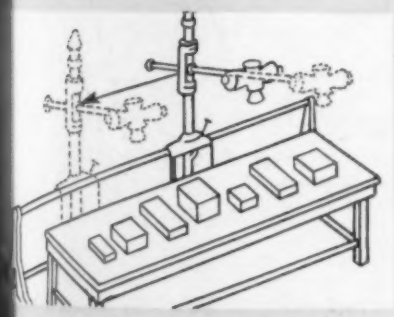
GET BOTH WITH THIS WESTINGHOUSE X-RAY UNIT

The Westinghouse Rail-Mounted X-ray Unit permits unusual speed and flexibility in the x-ray department. Rated at 140 kv capacity, it is especially suited for the inspection of light alloy parts and moderate thicknesses of heavier metals. Its control is largely automatic . . . easy to adjust for proper exposure.





Check the many features of this 140 kv unit. It will make a profitable investment for your plant, both now and after the war. Your nearest Westinghouse X-ray Office has full details. Or write Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., Dept. 7-N.

SPEED TO INSPECT MORE PARTS FASTER.

This unit is designed to save time. Parts can be placed on a large worktable and radiographs made, one after the other, simply by moving the unit to the next position. Parts of varying sizes and shapes can be x-rayed quickly, since the tube-head adjusts easily and the controls are simple. When parts are identical, the radiographic work is reduced to sliding the unit along the rails and making successive exposures.

FLEXIBILITY TO INSPECT MORE KINDS OF WORK.

This unit also has the flexibility demanded in today's production. Ideal for light alloy work, it quickly penetrates aluminum up to 7½" thick. In addition it will produce sharp, detailed radiographs through 1½" of steel; 1" of brass. The counterbalanced tube-head and tube-arm permit the beam to be raised, lowered and directed over a large area with speed and great accuracy. The entire unit occupies a minimum of floor space, a large part of which is available for positioning the work.

J-02012

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PLANTS IN 25 CITIES... OFFICES EVERYWHERE

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Muha, George J. (C), 930 Woodward Ave., McKees Rocks, Pa.
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Riley, Walter E. (C), 1620 Beechwood Blvd., Pittsburgh, Pa.

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Bradshaw, Louis J. (D), 801 No. I St., Tacoma, Wash.
Gugler, Lester E. (C), Shore Acres, Gig Harbor, Wash.
Hopkins, Howard E. (C), Seattle Tacoma Shipbldg. Co., Tacoma, Wash.
Kellam, M. H. (D), 4412 Forest Dr., Everett, Wash.
Murphy, F. X. (D), 1110—18th N., Seattle, Wash.
Voss, Joe E. (D), 2045 So. 8th St., Tacoma, Wash.

ROCHESTER

Cohen, Howard B. (D), 27 Carthage Dr., Rochester, N. Y.
Koubek, Wm. F. (B), Acme Elec. & Mfg. Co., Columbia St., Clyde, N. Y.

ST. LOUIS

Carl, Paul (C), Witts Trade School, 737 E. Cerro Gordo, Decatur, Ill.
Davis, Lawrence O. (C), 6900 Oleatha, St. Louis, Mo.
Hickman, Arthur R. (C), Guy H. Rumpf Machy. & Equip. Co., 1637 Railway Exchange Bldg., St. Louis, Mo.
Wulf, Kenneth J. (C), 5542 Ashland Ave., St. Louis, Mo.

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Campbell, Joseph (D), 1250 Navellier St., El Cerrito, Calif.
Colombo, Benjamin D. (D), 1275 E. St. Hayward, Calif.
Langston, Russell (B), Southern Pacific Co., Bayshore Shops, San Francisco, Calif.
McClure, C. E. (C), 335 Vermont Ave., Berkeley, Calif.
McCroskey, R. K. (B), 308 Ohio Ave., Richmond, Calif.
Parks, J. W. (B), Standard Oil Co. of Calif., 225 Bush St., San Francisco, Calif.
Southard, O. C. (B), United Welding Corp., 660 Golden Gate, San Francisco, Calif.
Staninger, Earl M. (D), 861 Sheridan, Vallejo, Calif.

SAVANNAH

Anderson, C. E. (C), 5 W. 55th St., Savannah, Ga.
Bibb, Daniel T., Jr. (C), 1001 E. Waldburg St., Savannah, Ga.
Beacham, Ansel F. (C), 211 E. 55th St., Savannah, Ga.
Bruno, Domenick (B), Graham Cottage, Savannah Beach, Ga.
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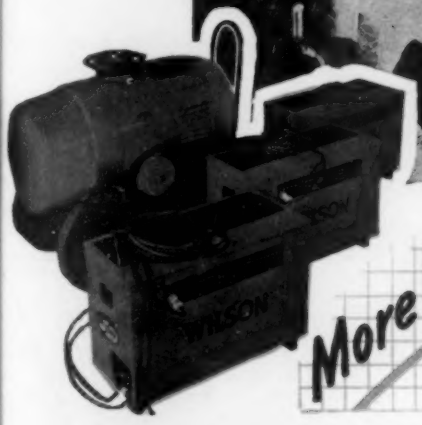
Comer, R. E. (B), % J. O. McBride, Garden City, Savannah, Ga.
Cowart, James R. (B), 1206 E. 49th St., Savannah, Ga.



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Markert, Thomas A. (B), Wall Chemicals Div., 200 N. Floyd St., Louisville, Ky.
Menna, Anthony (B), The Menna Welding Co., 1102 W. Central Ave., Toledo, Ohio.
Menna, Henry (D), The Menna Welding Co., 1102 W. Central Ave., Toledo, Ohio.
Mills, R. V. (C), Willys Overland Motors, Inc., Walcott Blvd., Toledo, Ohio.
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McNeal, Kenneth E. (D), 1215 Taylor St., Ft. Wayne, Ind.
O'Konski, Louis (D), The Menna Welding Co., 1102 W. Central Ave., Toledo, Ohio.
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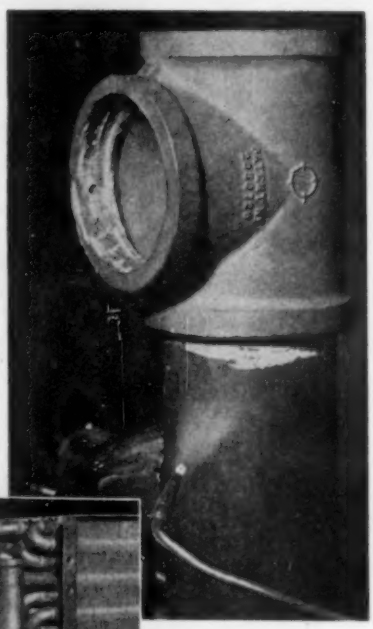

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They were well aware, too, that by eliminating threading and making practical the use of thinner walled pipe and tubing, Sil-Fos saved an immense amount of time and huge amounts of metal and weight — advantages that are now of such vital importance to the war effort.

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This bulletin gives you the specific reasons why Sil-Fos consistently makes leak-tight joints with speed, reliability and economy. Also contains valuable metal joining information. Write for your copy today.

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Sokoloff, R. M. (from D to C), 4649 W. Harrison St., Chicago, Ill.

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King, Myron A. (from D to C) 1354 Shawview Ave., E. Cleveland, Ohio.
Maine, J. F. (from C to B) 12003 Scottwood Ave., Cleveland, Ohio.

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Cochran, Harry W. (from D to C) 539 Linwood Ave., Springfield, Ohio.

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Michalak, George F. (from D to C) 2505 W. Jefferson Ave., Trenton, Mich.

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Coby, Edward (from D to C), 733 Prospect Ave., Bronx, N. Y.
Fontana, Peter (from D to C), 537—78th St., North Bergen, N. J.
Schneider, George (from C to B), Acetylene & Welding Equip. Co., 1065 Atlantic Ave., Brooklyn, N. Y.

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Hunter, R. C., Jr. (from D to C), 107 Halsey St., Newark, N. J.

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PHILADELPHIA

Malmesbury, Carl D. (from D to C), Carl Mackley Houses, Mand Bristol Sts., Philadelphia, Pa.

SAN FRANCISCO

Davidson, Perry (from D to C), 3110 Roosevelt Ave., Richmond, Calif.

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Gamache, Rodolphe W. (from C to B), 16 Thomas St., Springfield, Mass.

WESTERN NEW YORK

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Hohmann, Joseph P. (from D to C), Alloy Rods Corp., 501 Prospect, York, Pa.

NOT IN SECTIONS

Carroll, Frank E. (from D to C), 1327 Roosevelt Ave., New Albany, Ind.
Heisler, Edward R. (from D to C), 200 E. Brookland Park Blvd., Richmond, Va.
McNeil, J. K. (from D to C), General Elec. Co., 1001 Wolfe St., Syracuse, N. Y.

WELDING ROD RESTRICTIONS EASED

Commercial welding and repair shops have been experiencing difficulty in obtaining adequate supplies of welding rod unless they were working on war contracts or subcontracts that enabled them to furnish high priority ratings. This worked a hardship on a great many shops, particularly the smaller ones, which were not able to furnish such ratings.

The situation has been materially relieved, however, by Administrative Order No. 708–18 of the War Production Board recently issued to WPB district and regional offices. This order authorizes the Board's local offices to assign various ratings up to AA-2X for requirements of welding rod to be used for maintenance and repair. Ratings under this authorization are limited to a maximum value of $25, or 45 days' supply for the buyer, whichever is less. The order also provides that the Board's regional offices (those in the larger cities) can assign ratings up to AA-1 with the same limitations on quantity.

Welding shops that have available necessary repair and maintenance work and have been unable to obtain welding rod should apply for these ratings. Since WPB district offices can issue such ratings locally, the process is simple and suppliers who receive such orders can obtain the needed requirements through normal channels of distribution.

NEW CESCO CATALOG

A wide range of industrial safety equipment providing protection for the head, eyes, nose, throat, lungs and other parts of the body is described in the 25th edition of the Chicago Eye Shield Co. catalog.

Illustrations and descriptions include various types of protective lenses, goggles, welders helmets and shields, respirators, masks, grinder guards and toe guards. Copies available if requested on business letterhead by writing direct to manufacturer, Chicago Eye Shield Co., 2300-C Warren Blvd., Chicago, Ill.

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Am seeking position involving production methods and control in or outside of continental United States with a company or contractor developing welded products, especially in the alloy metal field.

Have some business management experience and am capable of working mass production or contract base jobs. I have four years practical welding experience in manufacture of heavy machinery and railroad equipment and four years welding in U. S. Naval shipyards. I have the experience plus the theoretical knowledge of weld practices covering steels, copper, brass, monel, chrome-nickel steels and other alloys.

Character and capability references; age 30; draft classification 3A. Replies held confidential. **Contact The Welding Journal Box A 451.**

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Space	One Insertion	Three Insertions	Six Insertions	Twelve Insertions
*Full Page	$120	$105	$95	$85
Half Page	70	60	55	50
Quarter Page	42	38	35	30
Eighth Page	30	25	20	18
*Inside Preferred	135	120	110	100

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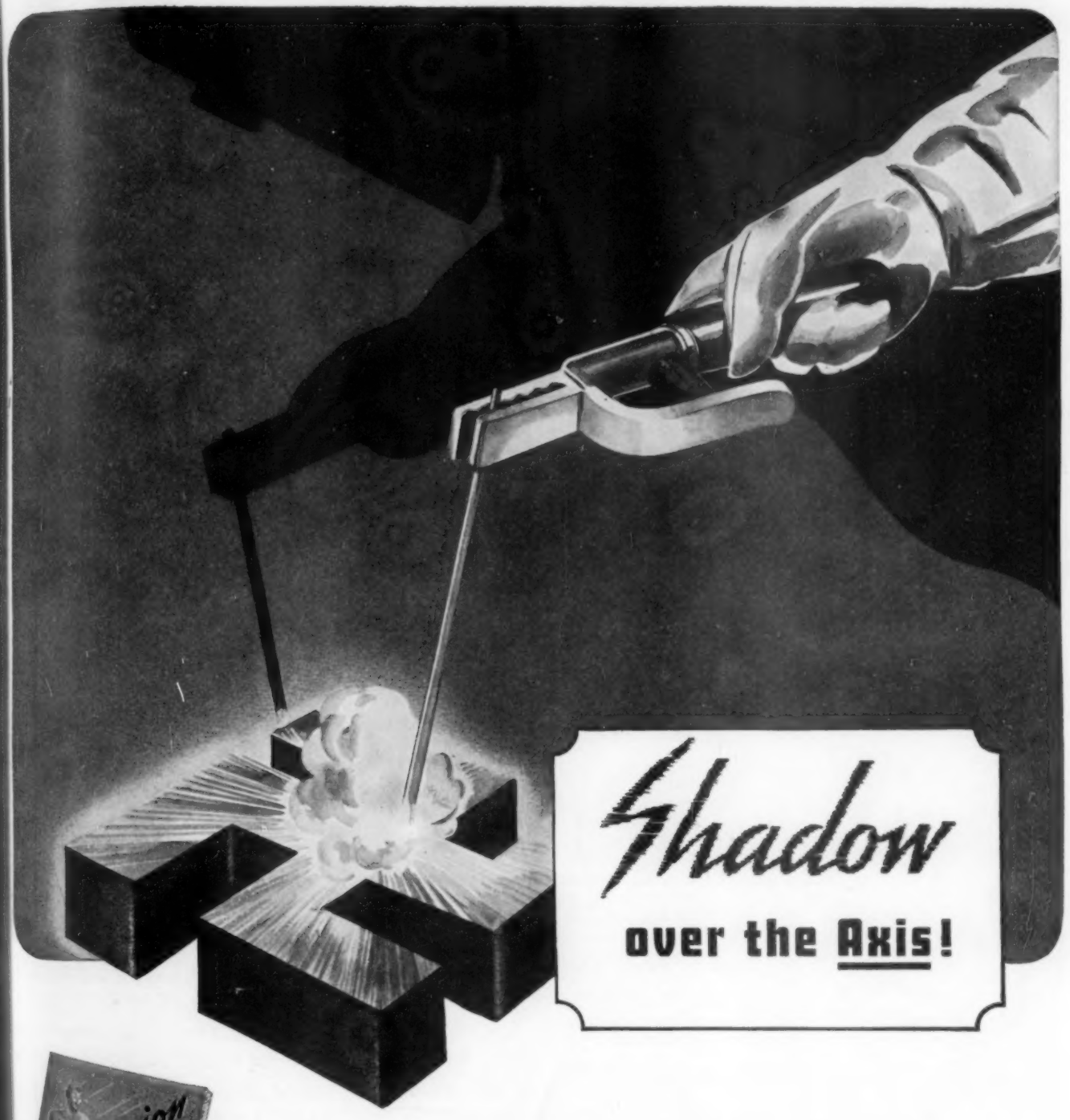

Champion Welding Electrode handbooks are obtainable for distribution to apprentice classes.

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Champion Welding Electrodes produce clean, smooth welds down to two inch stubs. Uncle Sam expects every operator to conserve by obtaining the utmost utility in each electrode.

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SECTION ACTIVITIES

BIRMINGHAM

Mr. Walter J. Brooking, Director of Testing & Research, R. G. LeTourneau, Inc., addressed the March 22nd meeting of the Birmingham Section on the subject of "The Control of the Arc Welding Process." Mr. Brooking's illustrated talk was followed by a sound movie on Arc Welding.

BOSTON

A highly successful one-man membership drive for the Boston Section is receiving many favorable comments. The driving force behind the campaign is a chap by the name of William J. ("Bill") Irvin, Quarterman Welder at the Boston Navy Yard, Boston, Mass.

"Bill," as he is most familiarly known around the Boston Navy Yard, is a rather unusual sort of a chap in several ways and the owner of a rather varied career. He was born in Dorchester, Mass., and attended grade and high school there. Between working and attending school, Bill managed to sandwich in enough time to

W. J. Irwin

study voice and piano and sing in the choir at church. By the time he was 16 years old he had his own orchestra, playing for dances and neighborhood functions. This lead to vaudeville in which he toured the country for several years. However, the call of the east was strong and he returned to locate at Nantasket Beach, then one of the great sea side summer resorts of the country. In 1916, Bill got interested in welding with both gas and arc. Those were the days the old timers recall that welders were few and far between. Water barrels were in common use, then. He managed to divide his time between welding them securely at Fore River Shipbuilding Company, Quincy, Mass., during the day, and pounding out with the "Dark Town Strutters Ball" in the evening at Nantasket Beach. He can be rated one of the pioneers on ship welding. He distinctly recalls the first important naval ship structural welding as being the Engine Room Skylight for the old four stackers of 1917–18. In 1921, he retired from the musical world to devote his energies to the welding field, traveling the length and breadth of the land as a welder and foreman. He returned to work as foreman for the B. F. Sturtevant Company of Hyde Park from 1927–29, then to the Walworth Company of South Boston. In 1933, he entered the Boston Navy Yard as a welder and has risen through the ranks to Quarterman Welder. He is always in demand to head the various entertainment committees and makes the perfect Master of Ceremonies.

CHATTANOOGA

The regular meeting of the Chattanooga Section was held on Friday evening, March 12th, at the Hotel Patten. The principal speaker, Mr. J. H. Humberstone, at present, Assistant Welding Supervisor for the War Metallurgy Committee and the National Defense Research Council, spoke on the subject "Classification, Identification, Application of Metal Arc Welding Electrodes." The meeting was opened with a movie showing the first two reels of the General Electric Technicolor film "Inside Arc Welding."

CHICAGO

On March 11th many members of the Chicago Section of the AMERICAN WELDING SOCIETY participated in the Chicago War Production Clinic which was held at the Medinah Club. The Clinic consisted of 24 panel sessions, four of which were devoted to welding. E. R. Seabloom, Chairman of the Chicago Section, was Chairman of the Panel Sessions Committee.

The four welding panels were devoted to: "Reclaiming of Cutting Tools, Milling Cutters and Broaches by Welding and Brazing," headed by T. B. Jefferson, Editor *The Welding Engineer* magazine and Secretary of the Chicago Section; "Problems in Resistance Welding of Various Materials," headed by E. R. McFarland, a former Chairman of the Chicago Section; "Application of Oxy-acetylene Welding, Brazing, Hardfacing, Flame Cutting and Hardening," by H. C. Boardman, a Past-President of the AMERICAN WELDING SOCIETY; and "Manual and Automatic Arc Welding, Atomic Hydrogen, Thermit, Hardfacing and Repair of Castings," headed by H. J. Kitcher, a member of the Chicago Section. L. S. McPhee who is also a Past-Chairman of the Chicago Section was a General Chairman of the welding panel. R. L. Kohlbry, Vice-President of the Chicago Section was Chairman of the Reception Committee of the Clinic.

On March 19th the Chicago Section held its March meeting. On this occasion the paper, "Hard-Facing a Means of Conserving Critical Materials," was presented. This paper was prepared by John R. Spence of the Stoody Company and read by T. B. Jefferson. Following the presentation of the paper a lively discussion on hard-facing and its application was conducted by J. C. Menzies

CINCINNATI

Mr. James F. Lincoln, Jr., of The Lincoln Electric Company, was the speaker at the April 12th meeting of the Cincinnati Section. Mr. Lincoln spoke on "Factors That Influence Weld Production."

CLEVELAND

The regular meeting of the Cleveland Section of the AMERICAN WELDING SOCIETY was held Wednesday evening, April 14th, at 8 o'clock at the Cleveland Engineering Society.

The speaker was Paul Homer Merriman, welding engineer, The Glenn L. Martin Co., Baltimore, Md. His subject was, "Rigid Engineering Control in Aircraft Welding."

Mr. Merriman, welding and electrical engineer, age 32, was graduated from the University of the South and Duke University with a B.S. degree in physics and electrical engineering. He started with The Glenn L. Martin Co. in 1933 at the bottom of the ladder working his way through the assembly line as an inspector, tool designer and welding engineer developing aluminum spot welding for the company.

He is chairman of the Eastern Division Aircraft Welding Committee and of the Aircraft Armor Subcommittee.

The talk concerned itself generally with the application of all types of welding in the aircraft industry including direct manufacture tooling, building construction, maintenance and repair. Types of welding discussed included arc, gas, resistance and brazing. Emphasis was placed on the necessity for rigid engineering control to realize the full potentialities of the process from the design of the part to the inspection of the finished article. Films and slides accompanied the talk which made it one of the outstanding meetings of the year.

The Coffee Talk, "Inside India," was given by Shanti Bahadur. This talk

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A welding symposium will be held at the Statler Hotel on May 14th.

COLUMBUS

The April meeting of the Columbus Section was held on the 9th at the Fort Hayes Hotel in the Blue Room. Dinner preceded the Technical Meeting. Mr. C. H. Jennings of the Westinghouse Electric & Manufacturing Co., discussed the subject "A. C. and D. C. Welding."

DETROIT

At the April 2nd meeting a "Stump the Experts" program was given in which the following participated: "Metallurgy of Welds," Clarence Altenberger, Great Lakes Steel Corp.; "Arc Welding," Leon C. Bibber, Carnegie-Illinois Steel Corp. and Ed. G. Biederman, Fisher Tank Division; "Flame Cutting and Hardening," Harold Kolkoesch, Ford Motor Co.; "Electronic Controls," George M. Chute, General Electric Co.; "Resistance Welding," John M. Diebold, Yellow Truck and Coach Div., General Motors Corp.

Mr. K. L. Hansen, President of the SOCIETY, very ably conducted the program which was full of spice and interest. The meeting was one of the best the Section has had and this type of program is recommended by the Detroit Section to other Sections.

One hundred and twenty members and guests listened again to Mr. L. C. Bibber, continue his excellent presentation on design for welding. As usual he did an outstanding job and the meeting had to be forcibly broken up at midnight.

The next meeting will be held on May 6th and will take the form of a social gathering.

The following officers were elected for 1943–44: *Chairman*, Earl H. Foss, Murray Body Corp.; *Vice-Chairman*, Henry C. Neitzel, Whitehead & Kales Co.; *Second Vice-Chairman*, George J. Friebel, Harnischfeger Corp., *Secretary-Treasurer*, George N. Sieger, S-M-S Corp.

GEORGIA

Mr. Roy E. Lorentz, Jr., of the Combustion Engineering Company, gave a very interesting talk on "Arc Welding and the Inspection of Welds with the 1,000,000-Volt X-ray Machine" at the March 25th meeting of this Section.

KANSAS CITY

The regular monthly meeting of the Kansas City Section of the AMERICAN WELDING SOCIETY was held Tuesday evening, March 2nd, in the Pine Room at Fred Harvey's. After the usual excellent dinner Chairman Farr announced the dinner guests: Mr. H. C. Heink, Asst. Manager of Sales and Director of Priorities, and Mr. F. C. Fantz, Vice-President in Charge of Production, both of Midwest Piping & Supply Co., St. Louis, Mo.

The 35 members present were then treated to an interesting, illustrated lecture by Mr. Fantz on the use of welding by his Company. For military reasons, full details could not be given, but it was evident that through welding, Midwest Piping & Supply Co., designed and fabricated much of its own machinery and jigs to produce "bigger, better and cheaper" bombs. The speaker traced the history of welding from forging and emphasized that welding was a process which made *one piece* out of two. In the post-war period, he assured his hearers, that welding definitely would come into its own in all types of construction.

Tuesday evening, April 6th, the regular monthly meeting of the Kansas City Section of A.W.S. was held at Fred Harvey's. A representative group was present to partake of the usual excellent dinner. After the serving, Chairman Farr called upon Mr. Jim Kirk, Chairman of the Nominating Committee to make his report. Adopting methods of the notorious Schickelgruber, Mr. Kirk announced, to their utter astonishment, the names of the newly appointed slate of executives, and called upon them "to collaborate." With their dissents smothered, and with the fear of being sent to some "concentration camp," the "slate" mechanically assented. For the 1943–44 period, the Kansas City Section will be officered by the following: Edgar H. Finlay, *Chairman;* E. D. Anderson, *Vice-Chairman;* Duane De Brunner, *Secretary-Treasurer*.

The main address was given by Mr. M. F. Barrett, Welding Engineer for Beech Aircraft Corporation, Wichita, Kan. His subject was "The Welding Process in the Construction of Aircraft." He stated that every known process of welding was used in the fabrication of airplanes, and that difficulties were always present but that his Company among others had done much to solve their welding problems by proper engineering design, the use of proper materials, jigs, operator training, tests and inspection, etc. He explained the use in his Company of oxy-acetylene welding as well as arc. He stated that the latter was coming more and more into prominence.

MILWAUKEE

The regular monthly meeting of this Section was held on March 26th. The After Dinner Talk was given by Fred Salditt, Vice-President, Harnischfeger Corporation, who spoke on "The Human Element in the Post War" Mr. L. S. McPhee, Welding Supervisor, Whiting Corporation, presented the welding address on "Design and Procedures."

NEW YORK

One of the most successful meetings of the New York Section was held Tuesday evening, April 13th, in the Auditorium of the Engineering Societies Building. Mr. Lyell Wilson, Assistant Chief Surveyor of the American Bureau of Shipping, presented an address on "Control of Welding." Mr. Wilson directed attention to the importance of procedure control and the sequence of welding with particular reference to the field of shipbuilding. The theme developed around the fact that it is absolutely essential not only to plan for the whole job in every detail, but also to make certain that such plans are fully and completely carried out. Mr. Wilson gave particular attention to some of the factors entering into the recent failure of the S.S. *Schenectady*. In the presentation of his report he drew heavily upon material prepared by Mr. LaMotte Grover in a paper published in the April issue of THE WELDING JOURNAL.

The Technical Chairman of the meeting was Mr. William Spraragen, Editor of THE WELDING JOURNAL and Executive Secretary of the Welding Research Council Mr. Spraragen gave a preliminary technical address on the subject of residual stresses and how these stresses were sometimes blamed directly for failures due to other causes, but which were only indirectly affected by residual or shrinkage stresses.

Considerable discussion followed Mr. Lyell Wilson's presentation.

The meeting was preceded by the usual question and answer period conducted by R. E. Bedworth, Westinghouse Elec. & Mfg. Co. and was followed by a motion picture on "Steel for the Armed Forces" shown through the courtesy of the Bethlehem Steel Company. This film was a recently produced soundfilm showing in an interesting and dramatic manner the various processes involved in the manufacture of steel.

At the annual Business Meeting to be held on Tuesday, May 11th at the Engineering Societies Building, A. M. Satapen, Handy and Harman, New York, will talk on "Silver-Brazing."

NORTHWEST

Mr. H. N. Ewertz, Sales Manager, Arcos Corporation, was the speaker at the March 15th meeting of this Section. Mr. Ewertz discussed the application of certain stainless steel electrodes to air-hardenable steels and used slides to illustrate his talk.

NORTHERN NEW JERSEY

The April meeting of this Section was held on the 20th at the Essex House, Newark, N. J. The meeting was opened with the showing of a motion picture, "Steel—Man's Servant," presented through the courtesy of the United States Steel Corporation. Four reels in full technicolor with Edwin C. Hill as narrator.

"Metallurgical Aspects of the Welding of Steel" was presented by Dr. R. H. Aborn, Research Laboratory, United States Steel Corporation.

OKLAHOMA CITY

Mr. Orville T. Barnett of the Metal & Thermit Corporation was the guest speaker at the April 2nd meeting. His talk was very well received. Mr. Barnett spoke on "Test Data of Mild Steel Electrodes."

PHILADELPHIA

Following the general business meeting on Monday evening, March 15th, Mr. LaMotte Grover, Air Reduction Sales Company, delivered an excellent talk on "What Shipwelding Experience Is Con-

Sections—CHAIRMEN, SECRETARIES AND REGULAR MEETING DATES

BIRMINGHAM — 3rd Fri.
CHAIRMAN—C. C. PINCKNEY, Birmingham Boiler & Eng. Co., 41st St. & 8th Ave., North, Birmingham, Ala.
SECRETARY-TREASURER—W. L. POOLE, Air Reduction Sales Co., 2825 N. 29th Ave., Birmingham, Ala.

BOSTON — 2nd Mon.
CHAIRMAN—F. W. DAVIS, E. B. Badger & Sons Co., 75 Pitts St., Boston, Mass.
SECRETARY—P. N. RUGG, 22 Eastern Ave., Wakefield, Mass.

CANAL ZONE — 1st Tues.
CHAIRMAN—CLIFFORD B. JONES, Box 533, Diablo Heights, Canal Zone
SECRETARY—R. E. HOLLICK, Box 924, Diablo Heights, Canal Zone

CHATTANOOGA, TENN. — 1st Wed.
CHAIRMAN—ROY E. LORENTZ, Combustion Engineering Co., Chattanooga, Tenn.
SECRETARY-TREAS.—A. R. MCLAIN, 14 S. Brooks Ave., Chattanooga, Tenn.

CHICAGO — 3rd Fri.
CHAIRMAN—ERIC R. SEABLOOM, Crane Co., 836 S. Michigan Ave., Chicago, Ill.
SECRETARY—T. B. JEFFERSON, *The Welding Engineer*, 506 S. Wabash Ave., Chicago, Ill.

CINCINNATI, OHIO
CHAIRMAN—R. L. KIRBY, R.F.D. No. 1, Box 131, Sharonville, Ohio
SECRETARY—GEO. A. JACOBY, 1743 S. Derexa Drive, Hamilton, Ohio

CLEVELAND — 2nd Wed.
CHAIRMAN—R. J. KRIZ, James Herron Co., 1360 W. 3rd St., Cleveland, Ohio
SECRETARY-TREAS.—A. LESLIE PFEIL, Universal Power Corp., Cleveland, Ohio

COLORADO — 3rd Wed.
CHAIRMAN—J. H. JOHNSON, Johnson Supply Co., Denver, Colo.

COLUMBUS, OHIO — 2nd Fri.
CHAIRMAN—CLAY W. ROBERTS, Pennsylvania R. R., Columbus, Ohio
SECRETARY—G. S. HERREN, The Seagrave Corp., Columbus, Ohio

CONNECTICUT — 1st Tues.
CHAIRMAN—B. H. PERRY, Bigelow-Sanford Carpet Co., Thompsonville, Conn.
SECRETARY—J. IMPERATI, American Brass Co., Ansonia, Conn.

DETROIT — 1st Fri.
CHAIRMAN—EARL H. FOSS, Murray Body Corp., Detroit, Mich.
SECRETARY—G. N. SIEGER, S-M-S Corp., 1165 Harper Ave., Detroit, Mich.

GEORGIA — 1st Fri.
CHAIRMAN—MICHAEL C. STELLMAN, 1164 N. Highland Ave., N. E. Atlanta, Ga.
SECRETARY—J. V. TURNER, 336 Spring St., N. W., Atlanta, Ga.

HAWAII — Last Thurs.
CHAIRMAN—GEORGE GLOVER, W. A. Ramsay, Ltd., Honolulu, T. H.
SECRETARY—ALAN G. SLIPPER, Hawaiian Gas Products Co., P. O. Box 2454, Honolulu, T. H.

INDIANA — 3rd Fri.
CHAIRMAN—E. F. GILYEAT, J. D. Adams Mfg. Co., Indianapolis, Ind.
SECRETARY—H. D. WEED, P. R. Mallory & Co., Indianapolis, Ind.

KANSAS CITY, MO. — 1st Tues.
CHAIRMAN—WM. S. FARR, Air Reduction Co., Kansas City, Mo.
SECRETARY—EDGAR H. FINLAY, Finlay Engineering College, 1001 Indiana Ave., Kansas City, Mo.

LAKE SHORE
CHAIRMAN—FRED HERBST, JR., McMullen & Pitz Construction Co., 923 Commercial St., Manitowoc, Wis.

LOS ANGELES — 3rd Thurs.
CHAIRMAN—F. H. STEVENSON, Vega Aircraft Co., Burbank, Calif.
SECRETARY—E. O. WILLIAMS, Victor Equipment Co., Los Angeles, Calif.

LOUISIANA — 1st Fri.
CHAIRMAN—G. O. HUET, Higgins Industries, Inc., 1755 St. Charles Ave., New Orleans, La.
SECRETARY—A. E. ABAUNZA, Gulf Engineering Co., 916 Peters St., New Orleans, La.

MARYLAND — 3rd Fri., except April
CHAIRMAN—A. R. WYNN, 913 N. Hill Rd., Baltimore, Md.
SECRETARY—VAN RENSSELAER P. SAXE, 100 W. Monument St., Baltimore, Md.

MILWAUKEE — 3rd Fri.
CHAIRMAN—KEITH WALKER, 3721 S. Herman St., Milwaukee, Wis.
SECRETARY—GILBERT F. MEYER, Machinery & Welder Corp., Milwaukee, Wis.

NEW YORK — 2nd Tues, except when Joint Meeting is held
CHAIRMAN—W. A. HOWARD, Socony Vacuum Oil Co. Inc., 412 Greenpoint Ave., Brooklyn, N. Y.
SECRETARY—GEORGE SYKES, The Linde Air Products Co., General Publicity Dept., 30 E. 42nd St., New York, N. Y.

NORTHWEST — 3rd Wed.
CHAIRMAN—C. E. COMFORT, St. Paul Structural Steel Co., 162 York Ave., St. Paul, Minn.
SECRETARY—ALEXIS CASWELL, Manufacturers' Assoc. of Minn., 200 Builders Exchange Bldg., Minneapolis, Minn.

NORTHERN NEW JERSEY — 3rd Tues.
CHAIRMAN—T. B. SMITH, Federal Shipbuilding and Drydock Co., Kearny, N. J.
SECRETARY—W. H. HART, Chas. W. Krieg Co., 52-60 Dickerson St., Newark, N. J.

NORTHERN NEW YORK — Last Thurs.
CHAIRMAN—M. F. SAYRE, Union College, Schenectady, N. Y.
SECRETARY—R. S. PELTON, General Electric Co., Schenectady, N. Y.

OKLAHOMA CITY — First Thurs.
CHAIRMAN—FRANCIS SPREHE, Midwest Steel Co., 2 N. Indiana Ave., Oklahoma City, Okla.
SECRETARY—HOWARD N. SIMMS, Box 1714, Oklahoma City, Okla.

OMAHA
CHAIRMAN—B. L. FUCHS, Fuchs Machinery & Supply Co., 15th & Jackson Sts., Omaha, Neb.
SECRETARY—GEORGE A. THRAPP, The Baldach Co., 1201 California St., Omaha, Neb.

PEORIA—CENTRAL ILLINOIS
CHAIRMAN—CLIFFORD WIMMER, 1104 Ann St., Peoria, Ill.
SECRETARY—A. RUNKEL, R. G. LeTourneau, Inc., Peoria, Ill.

PHILADELPHIA — 3rd Mon.
CHAIRMAN—H. W. PIERCE, New York Shipbuilding Corp., Camden, N. J.
SECRETARY—H. CAREY BOSS, 248 Rhoads Ave., Haddonfield, N. J.

PITTSBURGH — Middle Wed.
CHAIRMAN—F. H. DILL, American Bridge Co., Ambridge, Pa.
SECRETARY—J. F. MINNOTTE, Minnotte Bros Co., 1201 House Bldg., Hays (Pittsburgh), Pa.

PUGET SOUND
CHAIRMAN—SYDNEY K. SMITH, American Bureau of Shipping, 1727 Exchange Bldg., Seattle, Wash.
SECRETARY-TREAS.—JOHN NELSON, Air Reduction Sales Co., 3623 E Marginal Way, Seattle, Wash.

QUAD CITIES
SECRETARY—J. W. SHUGARS, Lincoln Electric Co., Moline, Ill.

ROCHESTER, N. Y. — 1st Thurs.
CHAIRMAN—R. L. CATTANACH, American Laundry Mach. Co., 110 Buffalo Rd., Rochester, N. Y
ACTING SECY.—HAROLD J. KING, University of Rochester, Engineering Dept., Rochester, N. Y.

SAN FRANCISCO — Last Fri.
CHAIRMAN—ROBERT O. WALDMAN, Chicago Steel & Wire Co., 1043 Bryant St., San Francisco, Calif.
SECRETARY—R. E. LABAGH, Victor Equipment Co., 844 Folsom St., San Francisco, Calif.

ST. LOUIS — 2nd Fri.
CHAIRMAN—A. S. SCHWARZ, John Nooter Boiler Works Co., St. Louis, Mo.
SECRETARY—H. C. CLOSE, Machinery & Welder Corp., 700 S. Spring Ave., St. Louis, Mo.

SOUTH TEXAS
CHAIRMAN—J. M. HUGHEN, Penn Shipyard, Inc., Beaumont, Tex.
SECRETARY-TREAS.—A. E. WISLER, Hughes Tool Company, 300 Hughes St., Houston, Texas.

TULSA, OKLA.
SECRETARY—JAMES B. DAVIS, Tulsa Testing Labs., Tulsa, Okla.

WASHINGTON, D. C. — 2nd Tues.
CHAIRMAN—WM. E. MCKENZIE, 2909—5th St., S. E., Washington, D. C.
SECRETARY—B. J. BRUGGE, 410 Hill Building, 17th and I Sts., N. W., Washington, D. C.

WESTERN NEW YORK — 3rd Fri.
CHAIRMAN—JOHN BOS, JR., 60 Westfield Rd., Eggertsville, N. Y.
SECRETARY—R. S. LANE, Ross Heater & Mfg. Co., 1407 West Ave., Buffalo, N. Y.

WICHITA, KAN.
SECRETARY-TREAS.—R. L. TOWNSEND, 266 Minneapolis St., Wichita, Kan.

YORK—CENTRAL PA.
CHAIRMAN—E. E. ROUSCHER, A. B. Farquhar Co., York, Pa.
SECRETARY—C. E. LEWIS KERCHNER, 290 W. Cottage Place, York, Pa.

YOUNGSTOWN, OHIO — 2nd Mon.
CHAIRMAN & ACTING SECRETARY—T. D. FEATHERINGHAM, Youngstown Welding & Eng. Co., Youngstown, Ohio

tributing to Structural Welding." By means of slides, Mr. Grover illustrated the similarity between structural members of a present-day welded ship and welded buildings. Particular attention was called to the sub-assembly work which is now being incorporated into structural welding. The principal disadvantage which has restrained a complete conversion from riveted to welded construction is that of height and resultant difficulties in assembling on the job. In large buildings, this must necessarily be accomplished with the use of erection bolts. On the other hand, great strides have been made in one- and two-story structures where handling is comparatively simple.

The Fellowship Committee, which had been formed with Mr. O. J. Pearre as Chairman at one of the previous executive committee meetings, was seen in operation for the first time at this meeting with splendid results. A rack containing name badges for all active members was placed at the entrance to the meeting room and the members were requested to wear these during the meeting in an attempt to single out non-members and welcome them into our body. Following the meeting, a majority of those present retired to the rear of the room for refreshments in the form of beer and pretzels. This proved very successful in holding a larger group for general discussion which, previously, had been confined to those few who cared to migrate to the Club's bar.

PITTSBURGH

The March 17th meeting of the Pittsburgh Section was attended by approximately 100 members and guests.

The speaker of the evening was Mr. C. A. Liedholm, Chief Engineering Metallurgist of the Curtiss-Wright Corporation, Curtiss Propeller Division, Beaver, Pa., who discussed in a most thorough manner the "Welding of Propeller Blades," as manufactured by his Company.

Curtiss-Wright's hollow steel propeller blades for airplanes are made from tapered and formed S.A.E. alloy steel plates which are assembled entirely through fusion welding.

The shanks are welded by the Unionmelt process whereas the air foil sections are welded by atomic hydrogen. Cold shuts at the root of the shank welds are eliminated through acetylene welding inside the blades with a water-cooled acetylene torch.

The blades are die straightened, quenched and tempered to a minimum ultimate of 135,000 psi. These blades have to pass exacting X-ray and Magnaflux inspection and have close dimensional tolerances. They successfully withstand severe service involving high static and vibratory stress.

Following the presentation the meeting was thrown open for questions from the audience.

ROCHESTER

The Rochester Section held a joint meeting on April 12th with the American Society for Metals. The Coffee Talk was given by Mr. William Pidgeon, of the Pidgeon Shoe Co., who spoke on "Shoes and Leather Through the Ages."

Mr. J. J. Vreeland, Metallurgical Engineer, Chase Brass & Copper Company, presented the technical talk on "Welding of Copper and Copper Alloys."

SAN FRANCISCO

The February meeting of the AMERICAN WELDING SOCIETY was held on the 26th of February, at the California Golf Club, Baden, Calif.

The San Francisco Section departed from its usual procedure inasmuch as this was a dinner meeting.

The members were so pleased with the appointments it was agreed that the March meeting should also be a dinner meeting, and at the same place.

Mr. L. P. Henderson, of The Lincoln Electric Company, was the speaker for the evening—his subject, "Fleet Fillet Welding," was very well received and the discussion which followed brought out many interesting features.

SOUTH TEXAS

The South Texas Section held its regular meeting at the Houston Engineers' Club, Houston, Tex., March 18, 1943. Mr. William Loose of the Dow Chemical Company gave a very interesting talk about Dow Metal and its adaptability to welding. Mr. Loose is Dow's research engineer in Midland, Mich.

Mr. Loose touched on spot welding, gas welding, and discussed at length the arc welding of magnesium alloys. The arc welding is done with helium-arc, using a tungsten electrode. Since we had read about this process we were very interested to see the many samples of welds he had. Mr. Loose also showed several slides of production welding of magnesium alloys.

WASHINGTON, D. C.

On March 23rd the Washington Section's regular meeting was held. The Section was privileged to hear a very fine talk from P. H. Merriman, Chief Electrical Engineer of The Glenn L. Martin Company, Baltimore, who talked on Design and Use of Welded Joints in Aircraft." Mr. Merriman's talk was illustrated with slides and two reels of motion pictures. The Section was interested to see the considerable spot welding that is being done on aluminum aircraft structures. Mr. Merriman's explanation of procedures, techniques, limitations and range of applications was very clear and complete.

Prior to Mr. Merriman's talk and discussion three short movies were shown. These shorts, loaned by OWI, were titled, "Transportation," "Mission Accomplished" and "Anchors Aweigh."

It is expected to continue to have a few short movies from OWI on timely subjects before each meeting.

WESTERN MASSACHUSETTS

The organization meeting of the Western Mass. Section was held on March 29, 1943, at the Holyoke Y.M.C.A. Mr. F. H. Jones, preliminary chairman, called the meeting to order at 8 P.M. Present were Mr. E. R. Fish, of the Hartford Steam Boiler Inspection and Insurance Company, and District Vice-President of the New York and New England District; Mr. L. C. Bibber of the Carnegie-Illinois Steel Corp., and 47 members or candidates for membership.

Mr. Jones called upon Mr. Fish to present the Charter to the Section and to outline some of the history, development, publications and other benefits of the SOCIETY.

Mr. Fish's talk and his command of knowledge of the SOCIETY impressed the group and they responded with a fine ovation. Special tribute was paid by Mr. Fish to women welders of whom four were present.

Having thus been granted the official authorization to operate as a Section, the following officers were elected for the year: *Chairman*, Willard A. Emery; *First Vice-Chairman*, Vincent P. Marran, *Secretary*, John J. Kapinos; *Treasurer*, Howard Wa. Walsh. *Executive Committee at Large:* Herbert S. Hill, John R. Thompson, Frank M. Joseph, Peter P. Pieciak, Frank J. Riedl and Frank H. Jones.

Mr. Jones then turned the meeting over to Mr. Emery who gave a short speech of acceptance in which he emphasized the fact that the Section would be successful only with the sincere participation of the whole group.

Accompanied by lantern slides, Mr. L. C. Bibber presented a talk of interest to the group on the "Fundamentals of Arc Welding." Mr. Bibber's fluency on the subject was admired by all and it was the feeling that the Section was fortunate to have obtained such a highly qualified speaker.

Following Mr. Bibber's talk, Mr. Emery informed the group that the next meeting would be held approximately a month from date.

A vote of thanks was tendered to Mr. W. B. Strathdee, Membership Chairman of the Boston Section, who gave his assistance and the benefit of his experience in the preliminary organization of this Section.

YORK-CENTRAL PENNSYLVANIA

Mr. Bent Laune, Technical Engineer, Eutectic Welding Alloys Company, was the guest speaker at the March 17th meeting. Mr. Laune spoke on "New Welding Process and Procedures to Salvage All Tools and Metals."

Prof. W. J. Conley of the University of Rochester spoke on N. E. Steels, at the April 14th meeting.

Annual Meeting
Chicago
Morrison Hotel
Oct. 18-21, 1943
Plan to Attend